CUMULATIVE EFFECTS ON HUMAN HEALTH WITHIN THE HYDROELECTRIC SECTOR: A CASE STUDY OF MANITOBA HYDRO

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ABSTRACT

The construction and operation of hydroelectric projects consist of multiple activities in a single watershed, which can generate significant impacts on the surrounding biophysical environment and on the health and well-being of local communities. The impacts of those activities may be insignificant individually, yet together may have an important cumulative effect. The impacts of hydroelectric development on human health and well-being have been widely documented. Current practices of cumulative effects assessment (CEA), however, as conducted under project-based environmental assessment (EA), often fail to address the deeper issues of human health and social well-being. This thesis was developed to examine how health effects, including cumulative health effects, are considered within regulatory EA practices in the hydroelectric sector in Manitoba. This was achieved by reviewing the EAs of three recent hydroelectric projects –Wuskwatim Generating Station, Bipole III Transmission Project, and Keeyask Hydroelectric Generating Station – located in the Nelson River watershed in northern Manitoba. Results indicate that the consideration of human health issues in EA has gradually improved over time; however, the assessment of health impacts was invariably limited to physical health components and often lacked due consideration of broader social health issues. The inadequacy of the practice of health impact assessment (HIA) was also evident by the lack of health-related indicators and the poor consistency in the use of indicators across projects and over time for measuring and predicting changes in the health conditions of the communities due to project development. An in-depth analysis regarding the assessment of cumulative health effects was carried out in the CEA of the most recent hydroelectric development – the Keeyask project. The findings show that cumulative health effects were not adequately considered in each of the basic components of CEA – scoping, retrospective analysis, prospective analysis, and management measures. Improving the consideration of health in EA requires paying more attention to broader range of health determinants, including both biophysical and social determinants and their interconnectedness in EA. Moreover, there is a need to improve greater consistency in the use of health indicators across projects and over time. It can be assisted by developing standardized terms of reference (ToR) for project proponents to ensure the consideration and monitoring of those indicators used for development projects built within the same geographic region and affecting the same communities and environments. Approaching cumulative health effects in a

more regional and strategic framework of CEA, beyond the scale of individual projects, is likely to provide the best mechanism to understand and monitor the cumulative impacts of project development on the health and well-being of the affected communities.

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CEA: cumulative effects assessment

CEC: Clean Environment Commission

CEAA: Canadian Environment Assessment Agency

CRD: Churchill River Diversion

EA: environmental assessment

EIS: environmental impact statement

HHRA: human health risk assessment

HIA: health impact assessment

HVDC: high-voltage direct current

KHLP: Keeyask Hydropower Limited Partnership

LWR: Lake Winnipeg Regulation

NCN: Nisichawayasihk Cree Nation

NEPA: National Environmental Policy Act

NFA: Northern Flood Agreement

NFC: Northern Flood Committee

SEA: strategic environmental assessment

ToR: terms of reference

VC: valued component

WHO: World Health Organization

CHAPTER 1

INTRODUCTION

Canada currently is the third largest producer of hydroelectricity in the world (International Water Power and Dam Construction, 2012). In 2010, Canada has production capacity of more than 75,000-megawatts from approximately 529 plants across the country, accounting for 60 percent of Canada's total electricity generation (Natural Resources Canada, 2014). The top hydroelectricity producing provinces are Quebec, British Columbia, Manitoba, Ontario, and Newfoundland and Labrador, with over 95 percent of the total hydroelectricity generation in Canada (Canadian Hydropower Association, 2008). Hydroelectricity is often known as a relatively clean and renewable energy source. However, the construction of hydroelectric facilities has significant impacts on surrounding natural environments and local communities. Rosenberg et al. (1997) state that larger scales of hydroelectric projects have raised concerns about the spatial extent and longevity of environmental and social impacts as well as cumulative effects on a global basis.

The adverse impacts of hydroelectric development on the natural environment have been widely documented (e.g., Rosenberg et al., 1997; World Commission on Dam, 2000; Raadal et al., 2011; Fearnside, 2013). Reservoir flooding, for example, is one of the most environmentally destructive activities associated with hydropower development, resulting in the loss of biodiversity, habitat alterations, increasing photosynthetic production, and decreasing water quality (Rosenberg et al., 1997; World Commission on Dams, 2000; Goodwin et al., 2006). Hydroelectricity is commonly characterized as clean energy with regard to the emission of atmospheric pollutants, such as greenhouse gases. However, in fact, the construction activities of hydroelectric facilities, such as reservoir flooding can make a significant contribution to greenhouse gas emissions. This includes indirect emissions associated with the construction of hydro facilities, such as building roads and transmission lines, the transportation of materials and workers, and waste disposal and decommissioning (Steinhurst et al., 2012; Fearnside, 2013); as well as biomass decomposition due to flooding (Steinhurst et al., 2012) and the temporary loss of carbon sinks as vegetation is removed to support transmission line development (Madrigal and Spalding-Fecher, 2010).

The development of hydroelectric projects can also lead to a series of health and social impacts, which is the focus of this thesis. In Canada, many hydroelectric projects are built in regions inhabited largely by Aboriginal peoples (Fortin, 2001). Traditionally, Aboriginal people have a holistic view of the environment and link their lifestyle, social, economic, cultural, and health matters to the health of the environment (Kwiatkowski and Ooi, 2003); thus, the disturbances caused by hydroelectric projects can seriously affect the health and well-being of Aboriginal people. Consequently, without careful assessment and management, hydroelectric development can lead to significant impacts to Aboriginal health – both physical and social (Morimoto, 2013), and these impacts can be “spatially significant, locally disruptive, lasting and often irreversible” (World Commission on Dams, 2000).

The disturbance of aquatic environments by flooding, for example, can cause elevated mercury levels in aquatic organisms and increase water-related and vector-borne diseases which adversely affect the physical health conditions of the people who live near the impacted river system and harvest traditional foods (Health Canada, 2004; Steinmann et al., 2006; Namy, 2007; Cools et al., 2012). Large-scale hydroelectric projects are also associated with a variety of serious societal problems, such as changes in household size and structure; alteration of employment opportunities and income sources; changes in the access and use of land and water resources for Aboriginal traditional use purposes; changes in the nature and magnitude of different health risks; and a disruption of the psycho-social well-being of displaced individuals due to reservoir construction (Tilt et al., 2009). Project-induced displacement is one of the more pressing social health issues concerning hydroelectric development, which has received increased attention in recent years (Tilt et al., 2009; Cao et al., 2012; Thompson et al., 2014). Project-induced displacement has been classified as a type of involuntary migration, which has the similar attributes with other types of involuntary migration arising from natural or anthropogenic disasters (Cao et al., 2012). Although most project development is meant to improve local and regional economies and improve the lives of people, project-induced displacement and the loss of traditional lands and resources often ends up putting people in worse conditions, resulting in people suffering from a series of health and social problems such as increased vulnerability to disease, psychological distress, decline in social integration, and loss of cultural heritage (World Commission on Dams, 2000; Namy, 2007; Tilt et al., 2009; Cao, et al., 2012; Morimoto, 2013).

Understanding the impacts of hydroelectric development on the health and well-being of those communities and environments affected by development requires an understanding of its cumulative effects (Strimbu and Innes, 2011; Kentel and Alp, 2013). The impacts of hydroelectric projects can occur both suddenly, when rapid and substantial change happens to the land due to flooding events, and more gradually, through a gradual, cumulative process of deterioration, whereby underlying issues of community health can magnify the magnitude of the impacts (Loney, 1995). As such, the selected indicators need to capture both these short-term effects and more insidious and gradual impacts. They might also need to capture information concerning whether the impacts are reversible or cannot be addressed through future intervention. Cumulative effects are effects of an additive, interactive, synergistic, or irregular nature, that arise from often individually minor but collectively significant activities that accumulate over time and space (Harriman and Noble, 2008). In Canada, cumulative effects assessment (CEA) is a requirement of all project-level environmental assessments (EA) undertaken under the Canadian Environmental Assessment Act, 2012, and is variably required across provincial and territorial EA jurisdictions. Cumulative effects assessment is intended to capture broader regional issues of development, including how conditions change over time and across space due to multiple, compounding development actions and lasting or overlapping effects (Harriman and Noble, 2008). In practice, however, EA has been widely criticized for falling short of expectations, and not doing a sufficient job of effectively identifying, and managing, the cumulative effects of development actions in regions with a history of resource development (e.g. Duinker and Greig, 2006; Noble et al., 2011; Ball et al., 2012). In particular, the current practice of CEA in Canadian EA has come up short on addressing social impacts, and has largely failed to address the deeper issues of human health and community well-being (Mitchell and Parkins, 2011). Although the field of health impact assessment (HIA) has emerged to particularly consider the impacts of development on society, and is often done within project-based EAs to assist decision-making (Wright et al., 2005; Kwiatkowski, 2011), the complex interrelationships between health conditions and environmental change are not fully understood and captured in CEA practice (Banken, 1999; Birley, 2002; Steinemann, 2000; Morgan, 2011). Arguably, there is a need to approach human health impacts in EA as cumulative effects in order to better understand the core issues of health with respect to project development, thus providing important information to decision-makers.

1.1 Research objectives

The overall purpose of this research is to examine how health and well-being, particularly cumulative health effects, are considered in EA practices for major hydroelectric development initiatives. Attention is focused on the history of hydroelectric developments in northern Manitoba. The specific objectives of this research are to:

i. determine whether community health and well-being indicators are included in recent regulatory-based EAs for hydroelectric developments could be used to support CEA;

ii. examine whether and how the cumulative effects of hydroelectric development on human health and well-being are assessed in project-based EAs, and whether practice has improved over time; and

iii. identify opportunities and recommendations for advancing human health CEA in the hydroelectric sector.

1.2 Thesis organization

This thesis is presented in six chapters, including this introduction chapter, and follows a traditional format. Chapter 2 provides a literature context to human health and well-being and introduces the concept of health in CEA. In Chapter 3, the study area is described and a brief overview of hydroelectric development in northern Manitoba is presented. This is followed by the research methods. The results of the research are presented in Chapter 4, followed by a discussion and observations for better health CEA in Chapter 5. The thesis concludes with Chapter 6, which identifies areas for further research.

CHAPTER 2

LITERATURE REVIEW

Health impact assessment is rapidly evolving in the field of impact assessment. In Canada, HIA is integrated in the institutionalized framework of EA to ensure that health impacts are addressed within the assessment of project-based development for decision-making. Canadian HIA expands the traditional scope of health and adopts a holistic determinant of health model to comprehensively address community health issues induced by project development. However, the current practice of EA has been criticized in that it does not adequately address project impacts on human health and community well-being, particularly cumulative health effects (Mitchell and Parkins, 2011; Morgan, 2011). Cumulative effects assessment, as an integral component of the EA process (Duinker and Greig, 2006), is intended, in principle, to address "any cumulative effects that are likely to result from the designated project in combination with the environmental effects of other physical activities that have been or will be carried out" (CEAA, 2015). Potential health impacts thus need to be addressed within the process of CEA for development projects, which may provide a better understanding of the comprehensive health impacts of developments together with past, present, and reasonably foreseeable future human activities. This chapter presents an overview of health and health determinants, how health is integrated into Canadian EA, and establishes the need to approach health in EA as a cumulative effect.

2.1 Health and health determinants

The nature of health is complex and subject to change (Larson, 1999). There are various types of definitions of health (Larson, 1999; Cornaro et al., 2005). The most well-known definition is that presented in the Constitution of the World Health Organization (WHO), which defines health as "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity" (Larson, 1999). The WHO's definition acknowledges the influence of multiple social components and their complex inter-relationships (Health Canada, 2004).

The status of health and well-being is often determined by the use of health determinants, which are a range of behavioral, biological, socio-economic and environmental factors that can provide an indication of overall health and well-being while at the same time influencing that health (WHO, 1999; Scott-Samuel et al., 2001; Bronson and Noble, 2006). The WHO's definition of health implies a holistic interpretation of health, connecting the complex inter-relationship between health determinants (e.g. political, social, cultural and economic elements) with the biophysical environment (Health Canada, 2004). As such, a proposed project development that has the potential to affect the biophysical environment can also produce significant health impacts due the changes brought about, directly and indirectly, to the social environment (Health Canada, 2004). In order to adequately identify and evaluate the impacts of a proposed project development on human health and well-being, Health Canada (2004), based on the WHO's definition of health, recommends a framework of health determinants by which to approach health impacts through the regulatory EA process (Figure 2.1). In the framework, each health determinant is not only important to health in its own right but the determinants are interrelated (Health Canada, 2004). Each of these determinants, and the interrelated indicators often used in assessment, is defined briefly below.

2.1.1 Income and social status

People with higher income and social status tend to live longer, have better health and suffer less from disability; those with lower income and social status tend to die younger and suffer a greater burden of diseases and disability (Demakakos et al., 2008). Low socio-economic status may place individuals at risk of poorer health for a number of reasons, such as having poor living conditions, little knowledge about the negative consequences of unhealthy behaviours, or less access to health care (Hanson and Chen, 2007). There is no single best indicator of social status suitable for all settings (Galobardes et al., 2006). Based on existing literature, however, several indicators are often used to measure the conditions of income and social status, such as education level, income level, housing characteristics and occupation class (Demakakos et al., 2008; Hanson and Chen, 2007; Galobardes et al., 2006).

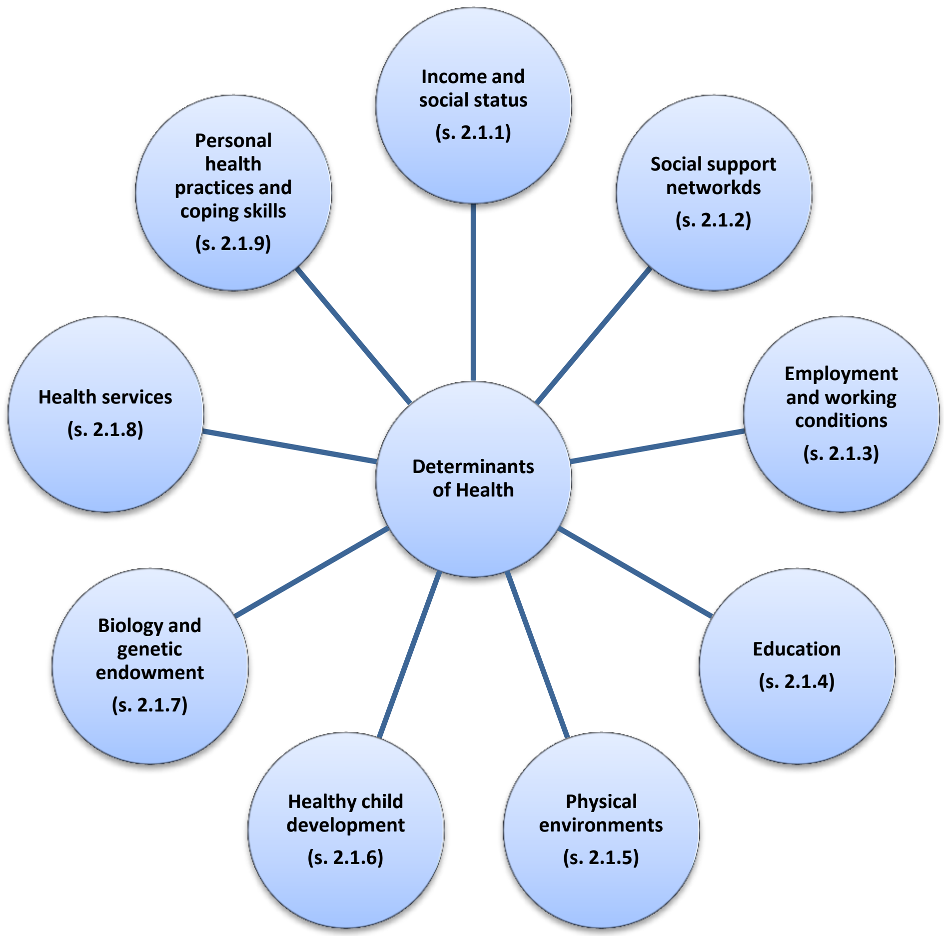

Figure 2.1 Determinants of health framework
Redrawn based on Health Canada (2004)

2.1.2 Social support networks

Social support networks refer to the support from social relationships such as families, friends and communities that surround individuals (Heaney and Israel, 2008; PHAC, 2013). Many studies indicate that people associate a high quality and quantity of social support and engagement with better physical and mental health conditions (Reblin and Uchino, 2008; Stephens et al., 2011). Social support can act like a buffer against health issues induced by stressful situations (Uchino, 2006). Social support networks influence health by many different pathways. There is no specific indicator used for assessing social support networks identified from the literature; however, Berkman et al. (2000) developed a conceptual framework that presents how social networks affect health based on macro-social conditions (e.g. culture, socio-economy, and politics) and psychobiological mechanisms (e.g. social support, person-to-person contact, and access to resources and material goods). The indicators used for addressing social and psychobiological conditions may be useful for measuring impacts to, or the status of, social network conditions.

2.1.3 Employment and working conditions

The influence of employment on health can be attributed, first, to increased monetary supports; and, second, to increased self-esteem, feelings of accomplishment, sense of identity and purpose, and increased social contacts and opportunities for personal growth (Nathanson, 1980; PHAC, 2013). More specifically, Benach et al. (2010) note that the impacts of employment on health can be related to three aspects: working conditions, the conditions of employment, and employment relations. Working conditions relate to the tasks performed by workers; the way the work is organized; and the physical, chemical, biological and psycho-social working environments (Benach et al., 2007). The impacts of poor employment conditions on health are not only a matter of unemployment but also of precarious employment, which involves work that lacks in standard employment relationships, such as insufficient social benefits, job insecurity, low wages and high risks of injury (Benach et al., 2007; Block, 2010). The indicators used for assessing the impacts of employment and working conditions on health and well-being are numerous. Anker et al. (2003), for example, suggested 30 possible statistical indicators, categorized into eleven groups for assessing employment and working conditions. Included amongst these indicators, for example, is labour force participation rate, employment-population ratio and unemployment rate, job tenure less than one year, temporary work, occupational injury rates, occupational injury insurance coverage, and hours of work (Anker et al., 2003).

2.1.4 Education

Numerous studies have found that people with greater educational attainment are likely to have better physical and mental health conditions and a longer life expectancy (Pandit et al., 2009; Lodi-Smith et al., 2010). Education can determine through health-related knowledge and behaviors, such as understanding the importance of regular exercise or healthy eating habits (Egerter et al., 2009; Cutler and Lleras-Muney, 2010; Lodi-Smith et al., 2010). Educational attainment is also related to knowledge, cognitive skills, and literacy skills, which in turn help an individual in making better-informed choices about health-related behaviors (Pandit et al., 2009, Lodi-Smith et al., 2010; Cutler and Lleras-Muney, 2010). Education also has an indirect influence on health though its impacts on employment opportunities, working conditions and income, as well as social networks that provide financial, physical and emotional support to individuals (Grzywacz et al., 2004; Cutlet and Lleras, 2006; Egerter et al., 2009).

2.1.5 Physical environments

The impacts of physical environments on health encompass a wide range of factors, from global (climate change) to national and regional issues (air, social and water pollution) (AFMC, 2015). The focus of assessment is often on the exposure of individuals to contaminants in the environment such as through air, water, soil and foods. Exposure is then associated with risk, typically in relation to chronic diseases, cancers, birth defects, respiratory dieses, and communicable diseases (PHAC, 2013; AFMC, 2015). In addition, many recent studies have also identified that health is related to the built physical environment, such as indoor air quality or access to outdoor recreational opportunities (Owen et al., 2004; Wendel-Vos et al., 2004; Gebel et al., 2007; Mitchell and Popham, 2008).

2.1.6 Healthy child development

Healthy child development captures the physical, social/emotional, and language/cognitive domains of development (Siddiqi et al., 2007), and is often approached based on assessments of the family environment, residential community and relational community (Siddiqi et al., 2007). Family environment is the primary source of life experience for children, and studies show that the socio-economic status of a family is relevant to the health, cognitive, and social and emotional well-being of a child (Bradley and Corwyn, 2002). Residential community refers to the community that children and their family live in, which includes the economic, physical, service and social environment, and is often understood based on such socio-economic well-being measures as family income levels, educational attainment, and the percentage of employed or unemployed individuals in the community (Siddiqi et al., 2007). Relational communities are the communities connected based on commonalities in religion, race or ethnicity, tribe or other similar characteristics (Siddiqi et al., 2007), important to the development of social identity, language and culture, and to the provision of social and emotional support systems (Siddiqi et al., 2007).

2.1.7 Biology and genetic endowment

The genetic endowment of an individual affects health not only directly by predisposing certain individuals to particular diseases (PHAC, 2013), but also indirectly through its influences on psychological traits and behaviors (Bouchard and McGue, 2003; Freese, 2008). Personality as the principle force underlying genetic influences has a strong relation with mental health issues (Schnittker, 2008; Bouchard and McGue, 2003). In addition, a number of studies in genetic association indicate that there are possible interactions between genes and culture (Barkow, 1984; Way and Lieberman, 2010). Way and Lieberman (2010) further suggest that genetic variations may interact with ecological and social factors to influence psycho-cultural differences.

2.1.8 Health services

Health services are designed to maintain and promote health, to prevent disease, and to restore function that contributes to population health (PHAC, 2013). Health care services include treatment and secondary prevention (PHAC, 2013), such as physical care, hospital care, dental care (Andersen and Newman, 2005). In a community, enabling conditions play a key role in making health services available for individuals (Andersen and Newman, 2005). The conditions are determined by family resources such as income and the enabling characteristics of the community, such as the number of health facilities and personnel in the community (Andersen Newman, 2005). Common indicators used for assessment include access to health services, diversity and type of available services, health services capacity, and population to physician ratio.

2.1.9 Personal health practices and coping skills

Personal health practices and coping skills refer to individual behaviors that can protect a person from disease, help them deal with challenges, and to make choices that enhance healthy outcomes (PHAC, 2013). Unhealthy lifestyles such as smoking, alcohol consumption, and limited physical activities have a strong relation with mortality rates (Belloc, 1973; Branch and Jette, 1984). Personal health practices are not only determined by an individual’s choices, but also influenced by socio-economic and physical environments (PHAC, 2013). There are five main pathways for impacts on personal health practices, including personal life skills, stress, culture, social relationships and sense of control (PHAC, 2013). Coping skills refer to thoughts and behaviors to manage the demands of stressful situations (Taylor and Stanton, 2007). Development of coping skills is an important strategy to assist individuals to reduce their vulnerability and improve self-efficacy when they are facing stressful environment so as to reduce stress-related mental and physical health issues (Smith, 1989; Litt et al., 2003). Taylor and Stanton (2007) suggest that coping skills can be influenced by four key resources – optimism, psychological control, self-esteem, and social support for managing stress (Taylor and Stanton, 2007). Some common indicators used in assessments of personal health practices and coping skills include gambling and addiction rates, smoking and drug and alcohol consumption rates, crimes against the person, and healthy eating habits. These are often related to other indicators associated with social support networks, employment and working conditions, education and use of health services.

2.2 Health impact assessment

Health impact assessment is defined as a combination of procedures, methods and tools by which a policy, programme or project may be judged as to its potential effects on the health of a population, and the distribution of those effects within the population (WHO, 1999). Unlike EA, there is no statutory requirement for a HIA in most countries, including Canada (Phillips et al., 2010). As well, HIA in current practice has appeared in several different forms such as integrated HIA, stand-alone HIA, and health equity-related HIA – each often addressing distinct but related concerns (Harris-Roxas and Harris, 2011).

The origins of HIA can be traced to the integrated framework of EA, which was first introduced in 1969 under U.S. National Environmental Policy Act (NEPA), the first EA legislation (McCaig, 2005; Bhatia and Wernham, 2008; Morgan, 2011; Harris-Roxas et al., 2012). The protection of human health and welfare was included in the objectives and regulations of NEPA (Bhatia and Wernham, 2008); however, early practices of EA often concentrated on the biophysical environment, and neglected issues of health impacts. It was not until the 1980s that HIA was proposed, referred to as Environmental Health Impact Assessment, by the World Health Organization (WHO) as a means to include health and safety components within the process of EA in order to inform decision-makers about possible health impacts due to project developments (Steinemann, 2000; Harris et al., 2009). The traditional approach to HIA was based mainly on quantitative methods, such as epidemiology and toxicology, to analyze and estimate linkages between environmental hazards and health outcomes, which Kemm (2000) described as a tight focused, and arguably limited, HIA (see also Cole and Fielding, 2007;

Harris-Roxas and Harris, 2011). This “tight” approach to HIA was, and still is, project focused, which fit well with the existing EA framework at that time (Cole and Fielding, 2007). This integrated model of HIA is currently the model of practice in countries such as Canada, Australia and New Zealand (Ahmad, 2004; Bhatia and Wernham, 2008; Morgan, 2011).

The tight focus of HIA, however, was criticized by a number of authors in the 1990s and 2000s (e.g. Davis and Sadler, 1997; Steinemann, 2000; McCaig, 2005). Steinemann (2000), for example, states that the term “health” implies not only physical health but also a state of social well-being; nevertheless, the assessment of health impacts was usually limited to quantitative analysis of the relationship between a single substance (e.g. water or soil contaminant or toxin) and a single health effect. There also emerged increasing recognition of the importance of social components, such as economic and institutional conditions, playing vital role in determining health outcomes, or the social determinants of health (Harris-Roxas et al., 2012). Social determinants of health are also referred to as “the causes of the causes” (Wilkinson and Marmot, 2003) because they are often embedded causes of health conditions (WHO, 2008; Harris-Roxas et al., 2012).

In order to explore how to improve the practice of HIA in regulatory EA, an international study of the effectiveness of EA and human health was led by Canada and the Netherlands (Davis and Sadler, 1997). The study concluded that HIA can be adequately addressed in the framework of EA, but two crucial improvements are needed – strengthening the role of human health in EA; and expanding the scope of impact assessment to recognize the holistic definition of health (Davis and Sadler, 1997; Morgan, 2011). The need to expand the scope of health impacts from the rigid physical model to one that includes a broader range of health determinants has had a significant impact on health integration in the framework of EA globally (Morgan, 2011). Canada, in particular, is a well-known leader in the broadening of the scope of health in EA by developing a holistic framework of health determinants for assisting the assessment of health impacts in regulatory-based EA for project developments (Kwiatkowski and Ooi, 2003; Health Canada, 2004; McCaig, 2005; Bronson and Noble, 2006; Morgan, 2011).

The evolution of HIA has also been influenced by trends under the banner of healthy public policy, influenced by fields allied to public health such as health promotion, health needs assessment, and evidence-based medicine (Ahmad, 2004; Harris et al., 2009). HIA under this banner emphasises a broad social view of health, which encompasses a full range of health determinants such as environmental, social, cultural and spiritual factors (Harris-Roxas and Harris, 2011; Morgan, 2011). It has been promoted to be undertaken as a stand-alone process that is not necessarily used only by the health sector but also by other sectors in order to ensure that potential health issues are considered at the scale of policies and programs, rather than limited to project-based assessments (Cole and Fielding, 2007; Harris-Roxas and Harris, 2011). The stand-alone HIA approach has the ability to identify and communicate significant health impacts at policy levels that are under-recognized or unexpected at other levels of assessment, such as wage laws, education programs, and urban redevelopment projects (Cole and Fielding, 2007). The province of British Columbia, Canada, was one of the first innovators in this field who attempted to institutionalize HIA as an independent policy device in 1994; however, it was shelved by the Ministry of Health in 1998 due to a lack of evidence indicating its effectiveness (Wright et al., 2005; Cole and Fielding, 2007). However, across the European nations, stand-alone HIA is regarded as a key approach to measure the impacts of policy on health determinants and fulfill European Union treaty obligations (Wright et al., 2005). It has also been acknowledged by a succession of official documents such as the white paper on public health in England, the Acheson report on social inequities in health, and the London Health Strategy (Joffe and Mindell, 2002).

The health equity-related model of HIA emerged as a further, distinct type of HIA that specifically tackles the issues of the differential distribution of potential impacts on different groups of the population (Harris-Roxas and Harris; 2011; Harris and Spickett, 2011). A health equity approach acknowledges that not everyone has the same level of health or same level of resources to treat their health issues, and thereby it may be important to work with people in different ways in order to work toward equitable health outcomes (Harris-Roxas et al., 2004). The health equity-related model of HIA was developed to use HIA methodology to identify the potential differential and distributional impacts of a policy, program or project on the health of the population, as well as specific groups in the population, and to assess whether the differential impacts are inequitable (Harris-Roxas et al., 2004). In Australia, a framework of equity focused HIA has been developed to produce explicit guidance for practitioners on how to identify the differential distribution of impacts within the existing process of HIA (Simpson et al., 2005; Harris et al., 2009). However, currently, there is no formal model of equity-related HIA internationally either at the policy, program or project level that consistently addresses the equitable distribution of health impacts (Harris-Roxas et al., 2004; Harris et al., 2009; Harris and Spickett, 2011).

The focus of this research is on integrated HIA, since in the Canadian context the regulatory EA process is the primary means by which health impacts are assessed for major resource development projects. Arguably, among the three types of HIA, assessing health impacts as an integrated part of regulatory-based EA may provide the best opportunity to assess and manage the impacts of resource development projects on human health and well-being, because it has the ability to encompasses the facets of all three domains – biophysical, social, and inter-and intra-generational equity, and is supported by an institutionalized processes of EA, which is a relatively sophisticated and accepted system globally (Ahamd, 2004).

2.3 Integrating health impacts in Canadian EA

In Canada, HIA is institutionalized federally as a part of the framework of regulatory-based EA (Wright et al., 2005) and, to varying degrees, under EA legislation of the provinces and territories. Environmental assessment in Canada was formally adopted in 1973 by way of the federal *Environmental Assessment Review Process*, replaced by the *Canadian Environmental Assessment Act* in 1995 (Noble and Bronson, 2005), recently repealed and replaced by the *Canadian Environmental Assessment Act, 2012*. The fundamental change to the *Canadian Environmental Assessment Act, 2012* is that the Act shifts from a trigger approach, where an EA is required depending upon a federal authority's involvement in a project, to a project list approach, where an assessment is required for only those projects identified on the federal regulatory list of "designated projects" (Ecojustice, 2012). The impacts of changes to the environment on human health conditions are necessarily incidental to federal EA decisions (Kirchhoff et al., 2013). The Canadian Environmental Assessment Agency (CEAA), for example, identifies the impacts that are directly linked to federal decisions, including: health and social-economic conditions, physical and cultural heritage, and structures of historical archaeological, paleontological or architectural significance (Kirchhoff et al., 2013).

The conventional way of approaching health in Canadian EA was based on quantitative analytic methods, such as risk assessments, to identify potential hazards and the relationship between the hazard and adverse health outcomes (Eyles, 1999). Assessing health impacts in EA was also largely done on an *ad hoc* basis, and dependent upon the willingness of EA practitioners (Davis and Sadler, 1997). The limitations of these early practices have been identified by many authors, including Davis and Sadler (1997), Steinemann, (2000), Cole et al. (2005), McCaig (2005), and Noble and Bronson (2005).

Canada's approach to assessing health impacts in EA changed in the late 1990s, based on concerns about the need to adopt a broader view of health in EA, and influenced largely by the publication of *Canadian Handbook on Health Impact Assessment* (the Handbook) by Health Canada in 1999, revised in 2004, which provides a model of health determinants to incorporate the health in the EA process (Kwiatkowski et al, 2009; Kwiatkowski, 2011). The Handbook acknowledges the influence of social, cultural, spiritual, economic and other health determinants as being significant to human health, and that the interactions among those determinants and the natural environment creates a complicated interaction of factors determining quality of life, health and well-being (Kwiatkowski, 2011). The purpose of the Handbook was to assist health professionals in various fields (such as medical, social sciences, government and industry) to provide health advice in the process of EA and be a tool for EA practitioners who are not experts in health (Health Canada, 2004; Kwiatkowski, 2011). In order to explicitly address the societal issues in the HIA, Burdge's (2004) book, *The Concepts, Process and Methods of Social Health Impact Assessment*, provides a set of indicators and thresholds which can help to develop quantified value for healthy communities.

Canada has since been recognized as a world leader in expanding conventional approaches to HIA by adopting a wider determinants of health model for addressing health impacts in project-level EA (Bhatia and Wernham, 2008; Morgan, 2011). However, in practice, assessing health impacts in EA continues to face a number of enduring limitations and challenges (see Kwiatkowski and Ooi, 2003; Bronson and Noble, 2006; Morgan, 2011; Westman, 2013). For example, notwithstanding the determinants approach, the scope of health in Canadian EA continues to be criticized for its limited focus on physical health impacts due to changes in physical environments, rather than social health impacts *per se* (Noble and Bronson, 2006).

Health impacts also tend to be limited to the pre-decision stages of EA, with relatively less attention to post-decision follow-up and monitoring programs (Noble and Bronson, 2006). Strengthening the consideration of health impacts in EA also requires more focus on the connections between project activities and the determinants of health (Banken, 1999; Bronson and Noble, 2006), and on the connections between the impacts of multiple projects over time on human health and well-being. A comprehensive approach in conjunction with contextually relevant health determinants is needed to assist EA practitioners to consider the likely impacts of project activities, including indirect and cumulative change, on health determinants (Aura, 2008; Morgan, 2011).

2.4 Approaching health impacts in EA as cumulative effects

Cumulative effect assessment is an integral component of many EA processes (Duinker and Greig, 2006). There is no universally-accepted definition of a cumulative effect (Gunn and Noble, 2010; Sheelanere, et al., 2013); however, the concept is generally defined as changes to the environment that are caused by an action in combination with other past, present, and future human actions (CEAA, 2015). In Canada, under the *Canadian Environmental Assessment Act, 2012*, section 19 (1) (a) of the Act requires that an EA of a designated project must consider the environmental effects, including cumulative environmental effects, that are likely to result from the project in combination with other physical activities that have been or will be carried out. An EA under the Act must also take into account cumulative environmental effects when the significance of environmental effects is being determined, and as well as when mitigation measures and requirements of follow-up programs are proposed that would relate to cumulative environmental effects. The CEAA's 2015 *Operational Policy Statement* on cumulative effects outlines the requirements and approaches to assess cumulative effects under the Act. Additional technical guidance for practitioners is currently under development, which may provide useful methodologies to implement the Operational Policy Statement in the context of the Act.

Under the *Canadian Environmental Assessment Act, 2012*, in section 5, the term environmental effects encompass not only changes to biophysical components but also changes to such matters as health and social-economic conditions, physical and cultural heritage, and other human and social matters as a result of those biophysical effects (CEAA, 2015). The problem, however, both under federal practice and in EA practice in general, is that the social dimension of environmental effects, including human health and well-being, are often overlooked in CEA practice; when considered, the focus is on assessing basic social conditions (e.g. population, employment) rather than deeper issues of community health and well-being (see Mitchell and Parkins, 2011). Loxton et al (2013) similarly argue that the current practice of CEA under project-based EA has focused on project-based development more so than on understanding holistic health impacts, and how their interaction and aggregation result in cumulative consequences. Good practice EA must pay more attention to the impacts that matter most, which do not result from a particular individual project but from the consequences of multiple projects and their interactions with the biophysical and human environment (Ehrlich, 2010). In other words, the impacts of development projects on human health and well-being need to be approached as a cumulative effect.

Many researchers (e.g., Duinker and Greig, 2006; Canter and Ross, 2010; Ball et al., 2012) have demand improved CEA; however, the social and health aspects of cumulative effects have received little attention (Olsson et al., 2004). For example, a model of CEA was recently established for watershed and river ecosystem management (Noble, et al., 2011; Ball et al., 2012), but it too failed to incorporate broader aspects of community health and well-being in a regional context. In principle, good CEA addresses not only project-specific impacts but also broader, regional issues (Harriman and Noble, 2008). Such an example of a relatively successful CEA research initiative for health and well-being was completed in the late 1990s, addressing the impacts on local communities due to environmental change caused by the large-scale James Bay energy development project (Olsson et al., 2004). The research documented what local communities perceived about the changes occurring in their area and other traditional knowledge, and this information was used not only as a baseline in the face of the hydroelectric projects being contemplated but was also followed up by scientists in future impact assessments (Olsson et al., 2004).

External to project-based EA, cumulative effects in regard to social aspects have been broadly discussed for land-use planning (Mitchell and Parkins, 2011; Spyce et al., 2012; Weber et al., 2012); however, currently, there remains a lack of adequate methodology to approach issues related to community and regional well-being in CEA. Mitchell and Parkins (2011) have identified and prioritized several social indicators – population growth rate, education attainment, self-assessed quality of life, equity, and locus of control – that could be applied in the model of cumulative effects for understanding human health. However, current social indicators are still not sufficient in themselves to develop a reliable and reasonable understanding of complex cumulative health effects to communities (Mitchell and Parkins, 2011). Furthermore, although much work has been done to understand social cumulative effects, empirical studies are lacking on social indicators that could be applied to evaluate the inputs or outputs for cumulative effects models in different types of communities and regions (Weber et al., 2012). A challenging task for social scientists is to estimate the correlative relationships among social, economic, and ecological indicators, and design an assessment that can "describe the dialectic relationship between ecological conditions and social and economic indicators so as to measure those most closely responsive to each other in communities under development pressure" (Weber et al., 2012). Therefore, there is a need to develop both theory and methodology for CEA in terms of identifying vital social and health indicators and understanding their interactions with the ecological system in order to develop a holistic and reliable scenario-based model to approach the core issues of human health and well-being. The current practice of CEA focuses on using technical models to assess social and ecological impacts, but often neglects the communities' preferences for the changes in their surrounding environment and how this translates to overall health and well-being (Spyce et al., 2012).

CHAPTER 3

METHODS

This thesis is based on a review of the EA documents of three hydroelectric development projects – Wuskwatim Generating Station, Bipole III Transmission Project, and Keeyask Hydroelectric Generating Station – the three recent hydroelectric generation and transmission development initiatives in northern Manitoba, all located in the Nelson River watershed. The EA documents include those relevant to the regulatory assessment of the hydroelectric projects. The primary method for this study was document content analysis (Babbie, 2001), similar to Retief's (2007) approach to evaluate the performance of strategic environmental assessment (SEA) through examining case studies in South Africa. This method was adopted in order to evaluate how human health and well-being were addressed in the current project-based EAs, and particularly in the CEA of the Keeyask project, the most recent project subjected to regulatory process.

3.1 Study area

Today, about 96 percent of the electricity in Manitoba is produced by 15 hydroelectric generating stations on the Nelson, Winnipeg, Saskatchewan, Burntwood and Laurie rivers (Manitoba Hydro, 2010). The Nelson River and Churchill River are the two largest rivers in northern Manitoba, roughly parallel to each other, draining northeastward into the Hudson's Bay (Figure 3.1) (Manitoba Wildlands, 2005). Hydroelectric development on the Nelson River started in the early 1960s, when the governments of Canada and Manitoba jointly initiated the construction of the Lake Winnipeg Regulation (LWR) and Churchill River Diversion (CRD) projects, the construction of a high-voltage direct current (HVDC) transmission system, and the building of a generating station (Manitoba Hydro, 2010). Currently, approximately 70 percent of Manitoba's hydroelectricity facilities have a total capacity of more than 3,500-megawatt, supplied by three large generating stations on the Nelson River – Kettle, Long Spruce, and Limestone (MCEC, 2014). Manitoba Hydro was set up as a Crown Corporation under the *Manitoba Hydro Act* in 1961, and is responsible for the supply of hydroelectricity in the province.

As a Crown Corporation, Manitoba Hydro is not only a commercial organization in its own right, but also a publicly owned utility that is responsible to the provincial government (Manitoba Hydro, 2010).

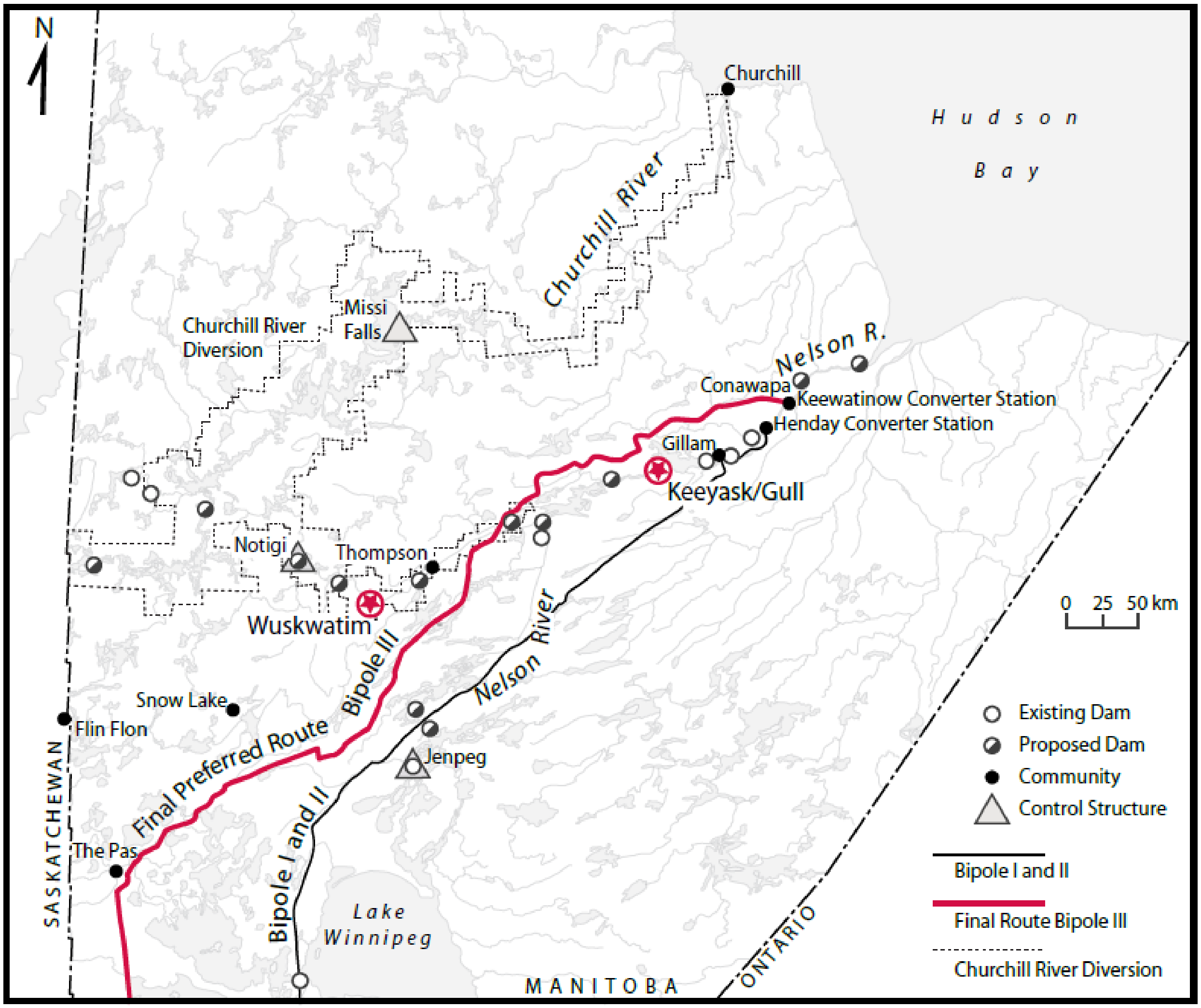

Figure 3.1 Hydro developments in northern Manitoba
Redrawn based on Manitoba Wildlands (2014)

3.1.1 A brief history of hydro development and regulation on the Nelson River

The potential for hydroelectric power on the Nelson River was identified by Manitoba and Canada in the early 1900s (Manitoba Hydro, 2010). In 1947, Manitoba Water Resources Branch did a survey on the upper streams of the Nelson River and concluded that approximately 160-megawatt of hydroelectric potential was available between Warren Landing and Cross Lake (Manitoba Hydro, 2014). Kelsey Generating Station was the first hydroelectric generator built on the Nelson River in 1960 to supply power to the International Nickel Company's mining operations near Moak Lake, and to the City of Thompson (Manitoba Hydro, 2010). Although the construction of Kelsey Generating Station was a relatively small project intended to serve consumers from the immediate region, it was an important step for the development of the Nelson River (Know History, 2015).

Other areas of hydroelectric potential were also being realized at around this time. In the late 1950s, the governments of Canada and Manitoba entered into an agreement and funded the Lake Winnipeg and Manitoba Board to carry out a flood control study of Lake Winnipeg, which concluded that regulating the lakes would be of benefit for exploring the hydroelectric potential on the Nelson River (Manitoba Hydro, 2010). In addition, a portion of the Churchill River was identified to have more than 3,000-megawatt hydroelectric potential (Manitoba Hydro, 2010). Instead of harnessing the potential power on the Churchill River itself, it was seen to be more economically feasible to divert the Churchill River into the Nelson River and develop hydroelectric facilities on the Nelson River (Manitoba Hydro, 2010). With the assurance of reliable outflow from the LWR project, the Churchill River Diversion (CRD) project could increase the potential power by as much as 40 percent (Manitoba Hydro, 2010).

The development of the Nelson River started in 1966 when the federal and provincial governments entered into an agreement to jointly carry out the construction of the hydroelectric potential on the Nelson River (Manitoba Hydro, 2010). The first phase of development consisted of the development of LWR and CRD projects; building a generating station at Kettle Rapids on the lower Nelson River; and the construction of converter stations and HVDC transmission systems lines (Manitoba Hydro, 2010). During that time, the advance of the HVDC technology was one of the keystones for northern hydroelectric development, which allowed the power to be transferred more effectively to the south (Manitoba Hydro, 2010). Two HVDC transmission lines were developed, Bipole I and Bipole II – one started at Raddison Converter Station and the other started at Henday Converter Station; both were terminated at Dorsey Converter Stations in southern Manitoba (Manitoba Hydro, 2010). The constructions of Bipole I and Bipole II were completed in 1971 and 1978, respectively (Manitoba Hydro, 2010).

In the 1980s, the Government of Manitoba introduced environmental licensing requirements for certain major development projects in the province, as part of a legislated environmental assessment process (Manitoba Hydro, 2010). The *Manitoba Environment Act* came into effect in 1988 (Lobe, 2009), replacing the former *Clean Environment Act* of 1968 and the Environment Assessment and Review process, which had been adopted as a provincial Cabinet policy in 1975 (Lobe, 2009). The new Act tied EA to project licensing requirements, requiring that certain major developments, public and private, be subject to a formal EA prior to issuing development licenses. The overall purpose of the Act is to "…ensure that the environment is maintained in such a manner as to sustain a high quality of life, including social and economic development, recreation and leisure for this and future generations" (p1(1)). Included in the Act, as a means to ensure public engagement in EA processes, was the establishment of the Clean Environment Commission (CEC), an arm's length body of government responsible for, among other things, holding public hearings as part of the EA and review process and providing advice and recommendations to the Minister of Manitoba Conservation and Water Stewardship (Lobe, 2009).

The Wuskwatim Generation and Transmission project was the first of Manitoba Hydro's projects that required regulatory EA and public review by the Commission (MCEC, 2013). The Wuskwatim Generating Station project is a 200-megawatt, run-of-river hydroelectric project involving development of transmission lines and stations on the Burntwood River at Taskinigup Falls (Manitoba Hydro, 2003). In 2006, the First Nation – Nisichawayasihk Cree Nation (NCN) – and Manitoba Hydro formally signed the Wuskwatim Power Limited Partnership Agreement to share the ownership and development of the Wuskwatim Generating Station; thus, Manitoba Hydro and NCN would be the proponent of this project (Manitoba Hydro, 2010). This was the first time in Canada that a First Nation community and an electric utility entered into a formal partnership arrangement for the construction of a major hydroelectric project (Manitoba Hydro, 2010). The Environmental Impact Statement (EIS) for the Wuskwatim project was prepared by Manitoba Hydro with the assistance of NCN and the Environmental Management Team which was selected by Manitoba Hydro and NCN (Manitoba Hydro, 2003). The construction of Wuskwatim project was completed and brought into commission in 2012.

Since then, the Bipole III Transmission Project and Keeyask Hydroelectric Generating Station Project on the Nelson River watershed have also been subjected to regulatory EA and review processes (Table 3.1). The construction of Bipole III and Keeyask projects is currently in progress. The Bipole III Transmission Project is a new 500 kilovolt HVDC transmission line project to improve the reliability of overall Manitoba Hydro's system and to reduce the severity of the consequences of major outages (Manitoba Hydro, 2011). Currently, approximately 70 percent of Manitoba's hydroelectricity is delivered to southern Manitoba via the Bipole I and Bipole II HVDC transmission lines from generating stations on the Nelson River to Dorsey Converter Stations in the northwest of Winnipeg (Manitoba Hydro, 2011). Similar to Bipole I and II facilities, the Bipole III transmission line is developed to deliver power from the new Keewatinoow Converter Station located near the future Conawapa Generating Station on the Nelson River to the future Riel Converter Station in southern Manitoba (Manitoba Hydro, 2011). Manitoba Hydro's approach to Aboriginal engagement was conducted through a variety of mechanisms such as the Environmental Assessment Consultation Process, Aboriginal Traditional Knowledge workshops and studies, and direct engagement between the Province of Manitoba and certain Aboriginal communities that may be affected by the proposed project (Manitoba Hydro, 2011). The Keeyask Generation Project consists of a 695-megawatt hydroelectric generating station at Gull Rapids on the lower Nelson River (KHLP, 2012). The Keeyask project is owned and operated by the Keeyask Hydropower Limited Partnership (KHLP), formed between Manitoba Hydro and four First Nations – Tataskweyak Cree Nation, War Lake First Nation, York Factory First Nation, and Fox Lake Cree Nation. In May 2009, the four First Nations and Manitoba Hydro singed the Joint Keeyask Development Agreement to develop a legal framework to ensure the project was developed in an environmentally and socially responsible manner (KHLP, 2012). Among the three projects, Keeyask is the most recent regulatory assessment in Nelson River watershed.

At the time of the submission of the proposals, under the Canadian Environmental Assessment Act, 1995, federal EA was required only if certain conditions were met. In the case of the three projects here, only Bipole III was determined not to trigger federal EA. The other two, Wuskwatim and Keeyask projects, required a full federal EA under the Fisheries Act and the Navigable Waters Protection Act.

Table 3.1 Descriptions of the three recent hydro generation and transmission projects in the Nelson River sub-watershed, Manitoba

Hydroelectric Projects	Project Descriptions
Wuskwatim Generating Station	• Generation Project: 200-megawatt generating station built at Taskinigup Falls on the Burntwood River • Transmission Project: o one 230-kilovolt transmission line between Wuskwatim and proposed Birchtree Station; o two 230-kilovolt lines between Wuskwatim and the existing Herblet Lake Station; o one 230-kilovolt line between Herblet Lake Station and Rall's Island Station; • Construction started in 2006 and was completed in 2012
Bipole III Transmission Project	• The project includes: o one 500-kilovolt HVDC transmission line linking Keewatinoow Converter Station on the Lower Nelson River to the future Riel Converter Station in southern Manitoba; o one 230-kilovolt ac transmission lines to connect the future Keewatinoow Converter Station to the existing Henday Converter Station and Long Spruce Generating Station in northern Manitoba; o two new converter stations: Keewatinoow Converter Station in northern Manitoba and Riel Converter Station in southern Manitoba, east of Winnipeg; o two ground electrode sites connected by a low voltage feeder line to the Riel Converter Station; • Construction began in 2014 with an anticipated in-service for 2018.
Keeyask Generating Station	• Generation Project: 695-megawatt hydroelectric generating station at Gull Rapids on the lower Nelson River; • Transmission Project: 138-kilovolt ac power transmission line, app. 22 km long; • Producing average of 4,400 gigawatt-hours of electricity each year; • Flooded land area: app. 45 km^2; • Total reservoir area: app. 93 km^2 • Construction period: app. 7 year, from 2014 to 2022.

(Sources: Manitoba Hydro, 2003; 2011; KHLP, 2012)

3.1.2 The socio-economic environment

The majority of the population affected by hydroelectric development in northern Manitoba is Aboriginal. The 2006 Census showed that Manitoba had 175,395 Aboriginal people, making up 15.5% of the population, and the highest provincial per capita numbers of Aboriginal people (Manitoba, 2012). There were 61,045 Aboriginal people in northern Manitoba, comprising 72.4% of the population in 2006 (Manitoba, 2012). The 2006 Census indicated that 39,660 or 73.9% of the northern Aboriginal people live on reserves (Manitoba, 2012). The northern Aboriginal people who live on reserves usually experience relatively lower levels of social and economic development, lower level of educational performance, and poorer physical health conditions than non-reserve populations (Freylejer, 2012). Freylejer (2012) reports that Aboriginal health in northern Manitoba has declined since 1985. The main reasons for the decline of northern Aboriginal health include the shortage of health services; increase in addictions – alcoholism in particular; deplorable housing conditions; and environmental disturbances, loss of land, and pollutions due to industrial developments such as mining activities and the development of hydroelectric projects (Freylejer, 2012).

Since the 1960s Aboriginal people's land and well-being have been affected by the construction of hydroelectric facilities in northern Manitoba (Waldram, 1988). In 1965, the people of Chemawawin, now Easterville, were asked to give up their lands for the development of the Grand Rapids Generating Station on the Saskatchewan River (Waldram, 1988). At the time, the Chemawawin community, located at the confluence of the Saskatchewan River and Cedar Lake, supported themselves through hunting, fishing, trapping, and occasional wage labor in a local small sawmill (Waldram, 1988). They had a rich social and cultural life with sufficient income from the abundant natural resources of the area (Waldram, 1988). However, since the Chemawawin people resettled in the new site Easterville, a series of social and health issues have emerged such as alcohol and substance abuse, social divisions, and unemployment (Waldram, 1988; Kulchyski and Neckoway, 2006). In addition, many Chemawawin people gave up their fishing, hunting and trapping activities because of the disturbance caused by flooding due to hydroelectric development (Waldram, 1988).

In the 1970s, there were more northern Aboriginal people affected by the development of the CRD project, such as the South Indian Lake community, who were also required to relocate to a new site, in the same way as the Chemawawin people had been (Waldram, 1988; Lienafa and Martin, 2010; Kamal et al., 2015). Hydroelectric development in northern Manitoba has generated dramatic changes in the environment, which significantly affect the life of Aboriginal people and their future generations. One of the major impacts on Aboriginal health and well-being is food insecurity, because traditional foods and medicines have been lost or degraded by the construction activities, particularly flooding, associated with hydro development (Loney, 1995; Kamal et al., 2015). In addition, there is an increase in health disparities and chronic diseases, such as diabetes in the communities affected by the CRD project because of the gradual dependency on commercial foods and lack of physical activity due to loss of traditional land access and use (Kamal et al., 2015). In the past, many Aboriginal people lived on wild meat and fishes, which are good sources of protein and minerals and contain less fat and cholesterol than commercial meats (Kamal et al., 2015). Active participation in hunting, gathering and eating traditional foods can help Aboriginal people prevent obesity and chronic disease (NCCAH, 2013). The significance of traditional foods to Aboriginal people is not only because of health benefit, but also the act of harvesting, collecting and sharing the foods plays a key role in sustaining strong connections with the land and their cultural identities (NCCAH, 2013). Moreover, a number of social and economic problems in the affected Aboriginal communities such as the growth of welfare dependency and alcohol and drug abuse are associated with the loss of harvesting area (Loney, 1995). The social, economic, health and cultural impacts of past hydroelectric development on the northern communities are clear. The impacts have endured and may be magnified over time in combination with upcoming hydroelectric projects. Kulchyski and Neckoway (2006) express that although hydroelectric power is known as clean and green energy, the hydro era opened a dark page in the history for the people in the north who have occupied the land for centuries. Loney (1995) suggests that the impacts of hydroelectric development on the northern communities must be understood as more than simply the sum of multiple discrete impacts; instead, understanding the cumulative effects of the hydroelectric projects can strike at the very core issues of community health and well-being.

The construction of the LWR and CRD projects significantly influenced the natural environment and had adverse impacts on the First Nations people who lived in the region. The Lake Winnipeg, Churchill and Nelson Rivers Study Board (the Study Board) was formed in 1971 to study the potential environmental and social effects of the LWR and CRD. The Study Board recognized that hydroelectric development was a significant factor leading to cultural change in the region, which “could result in a serious loss to the communities concerned, to Indian culture as a whole, and to the Province generally” (Know History, 2015). Three years later, in 1974, five northern First Nation communities – Nelson House, Norway House, Cross Lake, Split Lake, and York Factory – joined together and formed the Northern Flood Committee (NFC) to voice their concerns (Know History, 2015). In 1977, the NFC and the governments of Canada and Manitoba signed The Northern Flood Agreement (NFA) for the purpose of establishing framework to compensate the individuals or communities which adversely affected by the LWR and CRD projects (Manitoba Hydro, 2010). In the 1990s, Manitoba Hydro signed a total 14 agreements with the NFA regarding the impacts of hydroelectric development projects on the Churchill and Nelson rivers (Manitoba Hydro, 2010). In 1997, Manitoba Hydro began to collaborate with two First Nation communities, the Nisichawayasihk and Tataskweyak Cree Nations, to evaluate the potential hydroelectric sites in their resource management areas (Manitoba Hydro, 2010). An agreement in Principle was signed between Manitoba Hydro and the NCN in 2001 to provide the First Nation an equity position by investing proposed hydroelectric projects such as Wuskwatim Generating Stations (Manitoba Hydro, 2010).

3.2 Data collection and analysis

There is limited systematic research on the consideration of cumulative health impacts and well-being in project-based EA. How health impacts and cumulative effects are addressed in EA can vary considerably from one assessment to the next, influenced by the project context and project-specific Terms of Reference (ToR); thus, the design of an appropriate study strategy was challenging. Retief (2007), however, suggests an evaluation framework using case studies to evaluate the quality and effectiveness of the process of SEA through a combination of data sources, such as documentation and interviews. This thesis generally adopted Retief's (2007) approach to examine the weight of the consideration of health impacts in project EA documentation, and specifically the extent of consideration given to cumulative effects though the data obtained from the documents of the selected cases.

The primary method used in this research was document analysis – a qualitative research method used to categorize, investigate, interpret and identify written documents whether in the private or public domain (Mogalakewe, 2006). Document analysis has mostly served as a complement to other research methods; however, it also has been used as a stand-alone method (Bowen, 2009). Document analysis is useful because it examines and interprets data in order to produce meaning, gain understanding, and build up empirical knowledge (Bowen, 2009). The analytic procedure includes finding, selecting, appraising, and synthesizing the data that contained in the documents (Bowen, 2009). Document analysis is beneficial to provide background and context, supplementary data, a way of identifying change, and verification of findings from other data sources (Bowen, 2009).

The documents selected for review in this thesis are those that are relevant to the regulatory assessment of the three most recent hydroelectric projects in the Nelson River watershed, including the regulatory EISs, supporting volumes, technical reports, scoping documents, and reports on public hearings (Table 3.2). Most project documents were available in electronic form from online open sources, including the websites of Manitoba Hydro and the CEC. Original hard copies of project documents were required for only the Wuskwatim project – these were provided by the Manitoba Public Interest Law Centre.

Table 3.2 Hydro project EA document materials reviewed

	Wuskwatim Generating Station	**Bipole III Transmission Project**	**Keeyask Hydroelectric Generating Station**
Project EA Documents	Environmental Impact Statement	Environmental Impact Statement	Environmental Impact Statement (Response to EIS Guidelines)
		Aboriginal Traditional Knowledge TR**	
		Agriculture TR	
	Aquatic Environment SV*	Aquatic TR	Physical Environment SV
	Wildlife Environment SV	Birds TR	Aquatic Environment SV
	Forest SV	Caribou TR	Terrestrial Environment SV
	Land and Resources SV	Economic Impact Assessment TR	Socio-Economic Environment, Resource Use and Heritage Resources SV
	Socio-economic Environment SV	Electromagnetic Fields TR	Scoping Document
	Heritage Resources SV	Forestry TR	Report on Public Hearings
		Groundwater TR	
		Heritage TR	
		Land Use TR	
		Mammals TR	
	Report on Public Hearings	Resource Use TR	
		Socio-economic Baseline TR	
		Terrestrial Ecosystems and Vegetation TR	
		Terrestrial Invertebrates Amphibians and Reptiles TR	
		Scoping Document	
		Report on Public Hearing	
Other regulatory documents	Canadian Environmental Assessment Act, 2012 (and former Act)		
	Operational Policy Statement (OPS) for assessment of cumulative effects under the Act, 2012		
	The Environment Act (Manitoba)		

	Cumulative Effects Assessment Practitioners Guide (Hegmann et al., 1999)
*SV: EIS Supporting Volume **TR: EIS Technical Report	

The EA documents were analyzed in two phases. **Phase 1** involved an inventory of community health and well-being indicators included in recent regulatory-based EAs for each of the hydroelectric projects. A review of the Wuskwatim, Bipole III and Keeyask project EA documents was conducted to identify and categorize the types of indicators of human health and well-being considered in the project assessments, including the CEAs. For developing the inventory, the overall valued components (VCs) and their associated indicators used for both assessments of biophysical and socio-economic environment were first identified from the EAs and CEAs of the three hydroelectric projects. VCs/indicators identified from the assessment of the biophysical environment and associated impacts were considered as biophysical VCs/indicators; likewise, VCs/indicators identified from the assessment of the socio-economic environment and associated impacts were labeled socio-economic VCs/indicators. The VCs/indicators that have been used in at least two projects EAs and CEAs, and then across all three projects EAs and CEAs, were identified and considered as common VCs and indicators. For the Wuskwatim project, explicit VC-based terminology was not used; however, the assessment was still focused on specific ecosystem concerns and issues or components of traditional environmental value to local communities that could be categorized as VCs (Manitoba Hydro, 2003).

The common VCs and indicators were used to analyze the consistency of the indicators considered in the EAs of the projects, and thus were potentially useful for assessing and measuring potential cumulative effects. Sheelanere et al. (2013), for example, suggest that some consistency between project-based EAs on measuring and monitoring indicators and knowledge sharing are important for the effective practice of CEA, particularly when projects are located in the same watershed and affecting similar components. The number and percentage of biophysical VCs/indicators, socio-economic VCs/indicators, common biophysical VCs/indicators used in at least two projects, common socio-economic VCs/indicators used in at least two projects, common biophysical VCs/indicators used across all three projects, and socio-economic VCs/indicators used across all three projects were then extracted to determine the frequency of the use of the VCs and indicators across projects.

To understand the extent to which the three project EAs considered effects to human health and well-being, attention was focused on the socio-economic indicators identified from the inventory – namely those that could reasonably populate the framework of health determinants developed by Health Canada (2004). The framework includes nine determinants: social support networks, employment and working conditions, physical environments, education, healthy child development, biology and genetic endowment, health services, personal health practices and coping skills, and income and social status (Health Canada, 2004). The inventory was built by assigning the socio-economic indicators to the corresponding health determinants based on the understanding of the health determinants and their relevant indicators from the health-related literature research. Among the nine determinants, 'physical environments' was excluded from this assessment because it has been well covered in the health and EA research, in comparison to socio-economic aspects (Steinemann, 2000; Bronson and Noble, 2006; Birley, 2007; Kwiatkowski, 2011; Westman, 2013); however, attention was focused on the extent to which other determinants considered in the EAs were related to physical environments.

In addition, a thematic analysis was conducted on the EA documents of the three hydroelectric projects using a keyword search of health-related terms, such as "health", "health determinant" and "health indicators". The search of the keywords was done to examine how "health" was interpreted in the EA, specifically whether the project EAs fully adopted the WHO's definition of health as including physical, mental and social well-being (Health Canada, 2004). A review of the EA panel reports of the Wuskwatim, Bipole III, and Keeyask projects was also conducted, focused specifically issues related to community health and well-being to examine whether the consideration of those issues have advanced over time – i.e. whether issues and concerns noted by the CEC regarding human health and well-being for the Wuskwatim project were recurring in the Bipole III and Keeyask projects. The panel reports, also known as Report on Public Hearings, of the three projects were prepared by the Manitoba CEC, mandated under the authority of *The Environment Act* to facilitate public participation in environmental matters and provide advice and recommendations to the Minister of Manitoba Conservation and Water Stewardship (MCEC, 2014).

In **Phase 2**, a more in-depth analysis was undertaken, focused specifically on the Keeyask project, the most recent of the three EAs, to examine the extent to which cumulative effects to human health and well-being were considered. In principle, as the most recent regulatory assessment of hydroelectric development in the Nelson River watershed, the CEA of the Keeyask project should have addressed the combined effects of at least the previous two developments, in addition to the effects of present and proposed development. The evaluation of Keeyask's consideration of cumulative effects to health and well-being was framed based on the main components of 'good' CEA, as identified by a number of authors (e.g. Ross, 1998; Hegmann et al., 1999; European Commission, 1999; Duinker and Greig, 2006; Canter and Ross, 2010; Noble, 2010), and used by Noble and Gunn (2013) in their evaluation of the overall performance of the Keeyask project's CEA. These components are:

a) Scoping practices for cumulative effects: whether other projects and actions – past, present and future – are included when evaluating a project's contribution to cumulative processes of change affecting human health and well-being.

b) Retrospective analysis of cumulative effects: determining baseline health conditions, how conditions have changed over time, whether that change is significant to the health components (determinants) of concern (i.e. threshold determination, setting acceptable limits), and how and whether that change is contributed or connected to past and present development. An attempt is made to identify trends and association that can be used to predict conditions or responses to future cumulative changes.

c) Prospective analysis of cumulative effects: use of scenario-based approach to predict potential health impacts or responses to disturbances in the future, including disturbances directly attributable to the proposed project and to other present and future projects and actions within the project's regional environment.

d) Cumulative effect management measures: identify whether appropriate mitigation and monitoring actions have been identified for those health indictors (determinants) subject to cumulative effects.

CHAPTER 4

RESULTS

In this chapter the results of the analysis of the EA documents of the Wuskwatim Generation Project, Bipole III Transmission Project, and Keeyask Generation Project are presented. The chapter is comprised of five main parts. The first part presents the results of the inventory of VCs and indicators identified from the EA documents of the three projects, including common VCs and indicators. Next, the VCs and indicators identified in the CEA of each of the three projects are identified, as well as common VCs and indicators. The third part presents results of an inventory of health-related indicators from the three EAs that have the potential to be used to evaluate the impacts on human health and well-being for project-based EA and CEA, based on Health Canada's (2004) framework of health determinants. Fourth, results of a qualitative analysis of the nature and scope of attention given to human health and well-being is presented, in terms of how health and health determinants are defined and integrated in the EAs and EA panel reports. Finally, based on the most recent of the three EAs – the Keeyask project EA – results are subjected to a more detailed analysis of the nature and scope of consideration given to cumulative effects to health and well-being.

4.1 Identification of VCs from EAs of the three hydro projects

There were 114 VCs in total identified from across the EAs of the three hydroelectric projects; 80 of them were biophysical VCs, which made up 70%; 34 of them were socio-economic VCs, which made up 30% of the total VCs (Table 4.1). Common VCs, those VCs identified in two or more projects and across all three EAs, were also identified. There were 31 common VCs found in *at least two* EAs, accounting for 26% of total VCs; only 14 VCs were commonly used across *all three* projects, accounting for 11% of total VCs. Of the common VCs used in *at least two* project EAs, 13 were biophysical VCs, which accounted for 11%, and 18 were socio-economic VCs, which account for 16% of total VCs. For the common VCs identified across *all three* projects, 6 were biophysical (5% of total VCs), and 8 were socio-economic VCs (7% of total VCs).

Table 4.1 Identification of VCs from EAs of the three hydro projects

Environment	Categories	Valued components	VC presence in project EA		
			Wuskwatim	Bipole II	Keeyask
Biophysical environment	Aquatic environment	Surface water quality	•	•	•
		Lake whitefish	•		•
		Northern pike	•		•
		Walleye	•		•
	Birds and waterfowl	Mallard	•	•	•
		Bald eagle	•	•	•
		Olive-sided flycatcher		•	•
		Rusty blackbird		•	•
		Common nighthawk		•	•
		Canada goose	•		•
	Mammals	Caribou	•	•	•
		Moose	•	•	•
		Beaver	•	•	•
Socio-economic environment	Economy	Income	•		•
		Employment	•	•	•
		Resource economy	•		•
	Population, infrastructure and service	Community infrastructure and services	•	•	•
		Housing	•		•
		Travel and transportation services		•	•
	Personal, family and community life	Governance, goals and plans	•		•
		Community health and social well-being	•		•
		Public safety and worker interaction		•	•
		Travel, access and safety	•		•
		Culture	•	•	•
		Aesthetic	•	•	•
	Resource use	Domestic fishing	•	•	•
		Domestic hunting	•	•	•
		Trapping	•	•	•
		Commercial fishing	•	•	
		Traditional and medicinal plants harvesting	•	•	
	Heritage resource	Heritage resources	•	•	•

Based on the total of 80 biophysical VCs, the 13 biophysical VCs used in *at least two* projects accounted for 16% of total biophysical VCs; the 6 biophysical VCs used across *all three* projects accounted for only 8% of total biophysical VCs. Of the total 34 socio-economic VCs identified, the 18 common socio-economic VCs used in *least two projects* accounted for 53% of total socio-economic VCs; the 8 common socio-economic VCs used in *all three projects* comprised only 24% of total socio-economic VCs. The use of socio-economic VCs was more consistent across the three projects than the use of biophysical VCs. The common biophysical VCs used across all three projects were surface, water quality and wildlife VCs, namely specific wildlife species: mallard; bald eagle; caribou; moose and beaver. The common socio-economic VCs used across all three projects were: employment; community infrastructure and services; culture; aesthetics; domestic fishing; domestic hunting; trapping and heritage resources.

4.1.1 Identification of VC indicators from EAs of the three hydro projects

The condition of a VC, or potential threats to VC health, is typically assessed based on a number of measurable indicators. However, a VC itself sometimes can also be the indicator (Hegmann et al., 1999). There were 91 VCs for which an indicator could be identified, accounting for 80% of all VCs; 79 were biophysical VCs (87% of total VCs) and 12 were socio-economic VCs (13% of total VCs). Some VCs can be measured by more than one indicator. There were 188 indicators identified from the three hydroelectric project EAs; 146 were biophysical indicators, accounting for 78%; 42 were socio-economic indicators, accounting for 22% of total indicators.

The common indicators used in two or more project EAs and used across all three project EAs were identified in Table 4.2. There were 52 indicators found in *two or more* of the project EA, accounting for 28% of indicators; and 25 of them were found across *all three* project EAs, accounting for only 13% of total indicators. In terms of the indicators used in *two or more* projects, 35 of were associated with biophysical VCs, accounting for 19% of total indicators; 17 were associated with socio-economic VCs, accounting only for 9% of total indicators. Regarding those indicators identified across *all three* project EAs, 13 were for biophysical VCs, or 7% of total indicators; 12 of were for socio-economic VCs, or 6% of total indicators.

Of the total 146 biophysical indicators, the 35 biophysical indicators found in *at least two* projects made up 24% of total biophysical indicators; the 13 biophysical indicators identified across *all three* projects accounted for only 9% of total biophysical indicators. Of the total of 42 socio-economic indicators, the 17 socio-economic indicators used in *at least two* projects comprised of 40% of total socio-economic indicators; the 12 socio-economic indicators found across *all three* projects comprised only 29% of total socio-economic indicators. Socio-economic indicators were used more consistently across the three projects than biophysical indicators.

Table 4.2 Identification of indicators from EAs of the three hydro projects

Environment	Categories	Valued components	Indicators	Indicator presence in project EA		
				Wuskwatim	Bipole III	Keeyask
Biophysical environment	Aquatic environment	Surface water quality	Total suspended solid	•	•	•
			Turbidity	•	•	•
			Water temperature	•	•	•
			Dissolve oxygen	•	•	•
			pH	•	•	•
			Colour	•		•
			Hardness	•		•
			Alkalinity	•		•
			Total dissolved solids/conductivity	•		•
			Bacteria and parasites	•		•
			Major ions and trace elements	•		•
		Lake whitefish	Mercury concentration	•		•
			Other trace metals	•		•
			Internal parasites	•		•
			Fish palatability	•		•
		Northern pike	Mercury concentration	•		•
			Other trace metals	•		•
			Internal parasites	•		•
			Fish palatability	•		•
		Walleye	Mercury concentrations	•		•
			Other trace metals	•		•
			Internal parasites	•		•
			Fish palatability	•		•
	Birds and water fowl	Mallard	Habitat	•	•	•
		Bald eagle	Habitat	•	•	•
		Olive-sided flycatcher	Habitat		•	•
		Rusty blackbird	Habitat		•	•
		Common nighthawk	Habitat		•	•
		Canada goose	Habitat	•		•
	Mammals	Caribou	Habitat	•	•	•
			Abundance	•	•	•
		Moose	Habitat	•	•	•
			Abundance	•	•	•
		Beaver	Habitat	•	•	•
			Abundance	•	•	•
Socio-economic	Economy	Income	Income level	•	•	•
			Income sources	•		•

environment		Employment	Labour force	•	•	•
			Level of education	•	•	•
		Community health	Infant and maternal health	•		•
			Hospitalization	•		•
			Communicable disease	•		•
			Mortality	•		•
		Culture	Language	•	•	•
			Traditional knowledge	•	•	•
			Culture practices	•	•	•
			Health and wellness	•	•	•
			World view	•	•	•
			Kinship	•	•	•
			Leisure	•	•	•
			Law and order	•	•	•
			Cultural products	•	•	•

4.2 Identification of VCs from CEAs of the three hydro projects

In each of the three hydroelectric project EISs, there is a separate chapter for CEA. The CEA chapter in Wuskwatim's EIS is different from the other two project EISs, in that it only provides a framework as guidance for the practice of CEA, while in the EISs of Bipole III and Keeyask projects, the CEA chapter presents the results of the CEAs on selected VCs. Thus, the VCs that were used in CEAs are explicitly listed in the CEA chapter within Bipole III and Keeyask EISs. In Wuskwatim's EIS, the cumulative effects on the VCs are provided within each of the relevant sections of the EIS. There is no explicit criterion providing for the selection of VCs used in the CEA in Wuskwatim's EIS. In this case, the VCs used in the CEA essentially are the same as those selected in the EA. In the EISs of Bipole III and Keeyask projects, the VCs selected for CEA are determined based on the residual effects of the proposed projects. Consequently, if a VC is expected to experience adverse residual effects following prescribed mitigation, it was selected for inclusion in CEA.

There were 100 VCs in total identified from the three project CEAs, 69 were biophysical VCs and 31 socio-economic VCs, accounting for 69% and 31% of total VCs respectively. The VCs used in *two or more* CEAs and across *all three* project CEAs are identified in Table 4.3. Regarding the VCs identified from the CEAs, 18 VCs were found in *at least two projects* and only 8 were used across *all three* projects, comprising 18% and 8% of the total CEA VCs respectively. In terms of the VCs used in *two or more* project CEAs, 10 were biophysical VCs and 8 socio-economic VCs, which accounted for 10% and 8% of total VCs respectively. In terms of the VCs used across *all three* project CEAs, 5 were biophysical VCs and 3 were socio-economic VCs, which accounted for 5% and 3% of total VECs respectively.

Of the 69 biophysical VCs identified, the number of biophysical VCs used in *two or more* project CEAs accounted for only 14% of total biophysical VCs; the number used across *all three* project CEAs accounted for only 7%. Of the 31 socio-economic VCs identified, 26% were common in *two or more* projects; only 10% were common across *all three* projects. The use of socio-economic VCs in CEA across the three projects was more consistent than the use of biophysical VCs. The common biophysical CEA VCs used across all three projects included water quality, mallard, caribou, moose, and beaver. The common socio-economic CEA VCs across all three projects included aesthetics, culture, and heritage resources.

Table 4.3 Identification of VCs from CEAs of the three hydro projects

Environment	Categories	Valued components	VC presence in project CEA		
			Wuskwatim	Bipole III	Keeyask
Biophysical environment	Aquatic environment	Water quality	•	•	•
	Birds	Mallard	•	•	•
		Bald Eagle	•	•	
		Canada goose	•		•
		Olive-sided flycatcher		•	•
		Rusty blackbird		•	•
		Common nighthawk		•	•
	Mammals	Caribou	•	•	•
		Moose	•	•	•
		Beaver	•	•	•
Socio-economic environment	Infrastructure and services	Housing	•		•
		Infrastructure and services	•		•
	Personal, family and community life	Aesthetic	•	•	•
		Culture	•	•	•
		Community health	•		•
		Public safety and worker interaction		•	•
		Travel, access and safety	•		•
	Heritage resources	Heritage resources	•	•	•

4.2.1 Identification of VC indicators from CEAs of the three hydro projects

There were 79 VCs identified as having indicators associated with them in the CEAs of the three projects, accounting for 79% of the total number of VCs identified in the CEA sections of the impact statements; 69 were for biophysical VCs and 10 were for socio-economic VCs, accounting for 69% and 10% of total CEA VCs respectively. Some VCs identified in the CEAs had multiple indicators. There were 164 indicators identified from the inventory; 130 were biophysical indicators and 34 socio-economic indicators, accounting for 79% and 21% of total CEA indicators respectively.

The VC indicators used in at least two project CEAs and across all three project CEAs are identified in Table 4.4. There were 36 common indicators found in *at least two project* CEAs, and 21 identified across *all three* projects, comprising 22% and 13% of total indicators respectively. Of the indicators used in *at least two* project CEAs, 23 were biophysical indicators and 13 socio-economic indicators, or 14% and 8% of total indicators respectively. Of the indicators used across *all three* project CEAs, 12 were biophysical indicators, accounting for 7%; 9 of them were socio-economic indicators, accounting for 5% of total indicators.

Based on the total 130 biophysical indicators identified in the CEAs of the three hydroelectric projects, 23 were used in *at least two* projects, comprising 18% of total biophysical indicators; 12 were used across *all three* projects, comprising only 9% of total biophysical indicators. Based on the total 34 socio-economic indicators identified in the CEAs of the three hydroelectric projects, 13 were used in *at least two* projects, or 38% of total socio-economic indicators; 9 were used across *all three* projects, or 26% of total socioeconomic indicators.

Table 4.4 Identification of indicators from CEAs of the three hydro projects

Environments	Categories	Valued components	Indicators	Indicator presence in project CEA		
				Wuskwatim	Bipole III	Keeyask
Biophysical environment	Aquatic	Water quality	Total suspended solids	•	•	•
			Turbidity	•	•	•
			Water temperature	•	•	•
			Dissolved oxygen	•	•	•
			pH	•	•	•
			Colour	•		•
			Hardness	•		•
			Alkalinity	•		•
			Total dissolved solid/conductivity	•		•
			Bacteria and parasites	•		•
			Major ions and trace elements	•		•
	Birds	Mallard	Habitat	•	•	•
		Bald eagle	Habitat	•	•	
		Olive-sided flycatcher	Habitat		•	•
		Rusty blackbird	Habitat		•	•
		Common nighthawk	Habitat		•	•
		Canada goose	Habitat	•		•
	Mammals	Caribou	Habitat	•	•	•
			Abundance	•	•	•
		Moose	Habitat	•	•	•
			Abundance	•	•	•
		Beaver	Habitat	•	•	•
			Abundance	•	•	•
Socio-economic environment	Personal, family and community life	Community life	Infant and maternal health	•		•
			Hospitalization	•		•
			Communicable disease	•		•
			Mortality	•		•
		Culture	Language	•	•	•
			Traditional knowledge	•	•	•
			Culture practices	•	•	•
			Health and wellness	•	•	•
			World view	•	•	•
			Law and order	•	•	•
			Cultural products	•	•	•
			Kinship	•	•	•
			Leisure	•	•	•

4.3 Indicators used for assessing human health effects

Health Canada (2004) provides a framework of health determinants in their *Canadian Handbook on Health Impact Assessment* to assist EA practitioners and promote an integrated approach to assessing project effects on human health within the regulatory EA process. The framework consists of nine health determinants including: income and social status; education; employment and working conditions; physical environments; biology and genetic endowment; social support network; personal health practices and coping skills; healthy child development; and health services (Health Canada, 2004). Each of these determinants is not only important in its own right but they are also interrelated and can influence human health and well-being in ways that are more complex than each could do individually (Health Canada, 2004).

The status of each health determinant can be measured by multiple indicators, which have been widely documented in health-related literature. The following presents the socio-economic indicators identified, overall, from the EAs of the three hydroelectric projects, assigned to Health Canada's framework of health determinants (Table 4.5). The common socio-economic indicators used in at least two projects from both EAs and CEAs were also selected and assigned to the framework of health determinants (Table 4.6).

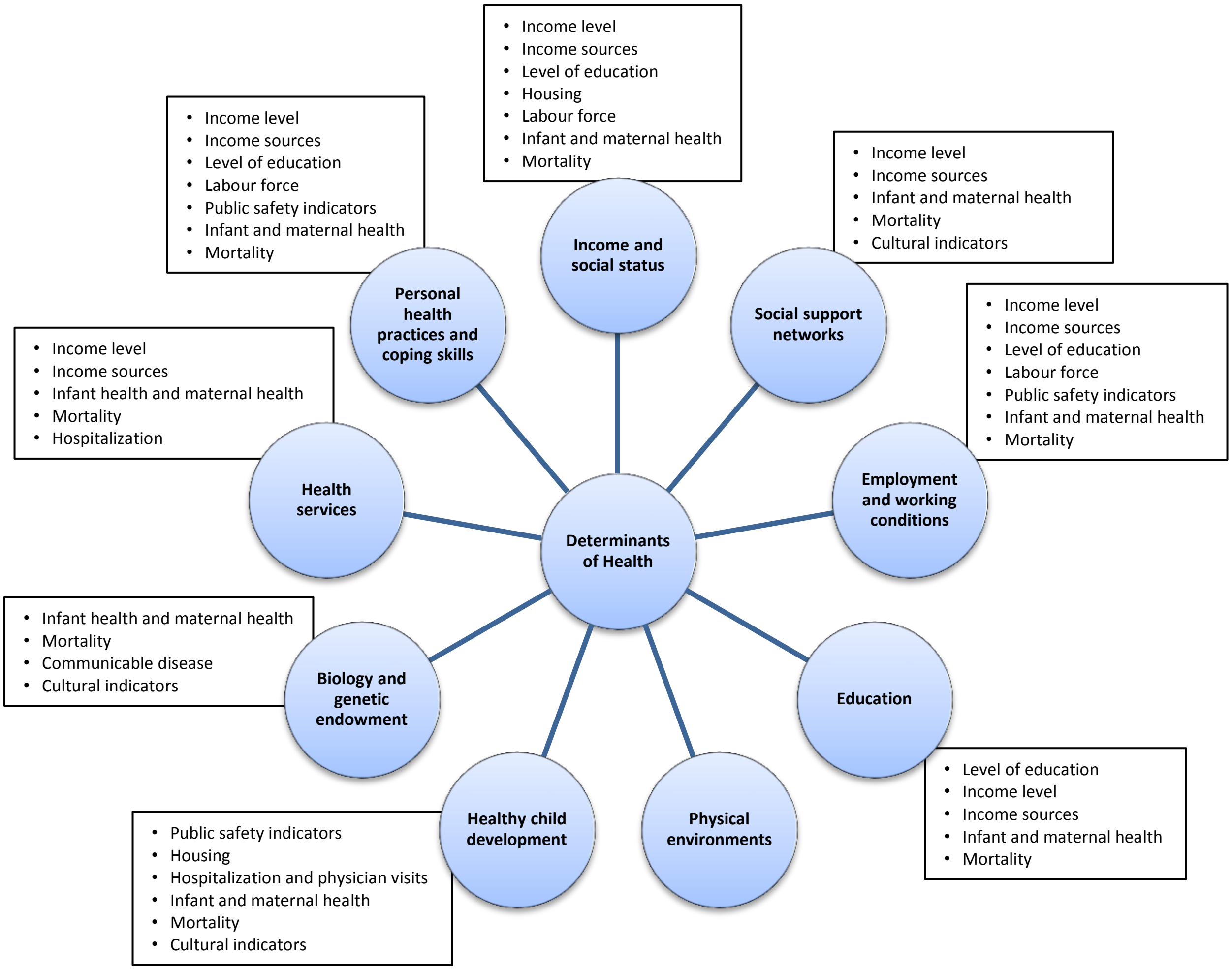

Figure 4.1 Project indicators corresponding to the health determinants

Table 4.5 All socio-economic indicators identified from the inventory and assigned to each health determinant (excluding physical environments)

Health Canada's health determinants	**Indicators identified in the EAs (including components addressed in baseline data/assessments/technical reports)**
Income and social status	Income level (e.g. income per person, employment income, household income, family income)
	Income sources (e.g. employment and self-employment income, government payments and interest and other investment income)
	Level of education
	Housing (e.g. housing cost, availability of housing)
	Labour force (e.g. participation rate, employment rate, unemployment rate)
	Infant and maternal health (e.g. birth rate, fertility rate, birth rate of teen mothers, high and low birth weight rate, infant mortality rate, and spontaneous abortion rates)
	Mortality (mortality rate, premature mortality, potential years of life lost)
Social support networks	Cultural indicators (language, traditional knowledge, culture practices, health and wellness, world view, law and order, cultural products, kinship and leisure)
	Income level (e.g. income per person, employment income, household income, family

	income)
	Income sources (e.g. employment and self-employment income, government payments and interest and other investment income)
	Infant and maternal health (e.g. birth rate, fertility rate, birth rate of teen mothers, high and low birth weight rate, infant mortality rate, and spontaneous abortion rates)
	Mortality (mortality rate, premature mortality, potential years of life lost)
Employment and working conditions	Labour force (e.g. participation rate, employment rate, unemployment rate)
	Public safety indicators (e.g. rates of property crimes; rates of violent crime)
	Labour force (e.g. participation rate, employment rate, unemployment rate)
	Income level (e.g. income per person, employment income, household income, family income)
	Income sources (e.g. employment and self-employment income, government payments and interest and other investment income)
	Level of education
	Infant and maternal health (e.g. birth rate, fertility rate, birth rate of teen mothers, high and low birth weight rate, infant mortality rate, and spontaneous abortion rates)
	Mortality (mortality rate, premature mortality, potential years of life lost)
Education	Level of education
	Income level (e.g. income per person, employment income, household income, family income)
	Income sources (e.g. employment and self-employment income, government payments and interest and other investment income)
	Infant and maternal health (e.g. birth rate, fertility rate, birth rate of teen mothers, high and low birth weight rate, infant mortality rate, and spontaneous abortion rates)
	Mortality (mortality rate, premature mortality, potential years of life lost)
Healthy child development	Infant and maternal health (e.g. birth rate, fertility rate, birth rate of teen mothers, high and low birth weight rate, infant mortality rate, and spontaneous abortion rates)
	Mortality (mortality rate, premature mortality, potential years of life lost)
	Cultural indicators (language, traditional knowledge, culture practices, health and wellness, world view, law and order, cultural products, kinship and leisure)
	Public safety indicators (e.g. rates of property crimes; rates of violent crime
	Housing (e.g. housing cost; availability of housing)
	Income level (e.g. income per person, employment income, household income, family income)
	Income sources (e.g. employment and self-employment income, government payments and interest and other investment income)
Biology and genetic endowment	Infant and maternal health (e.g. birth rate, fertility rate, birth rate of teen mothers, high and low birth weight rate, infant mortality rate, and spontaneous abortion rates)
	Mortality (mortality rate, premature mortality, potential years of life lost)
	Communicable disease
	Cultural indicators (language, traditional knowledge, culture practices, health and wellness, world view, law and order, cultural products, kinship and leisure)
Health services	Hospitalization and physician visits
	Income level (e.g. income per person, employment income, household income, family income)
	Income sources (e.g. employment and self-employment income, government payments and interest and other investment income)
Personal health practices and coping skills	Income level (e.g. income per person, employment income, household income, family income)
	Income sources (e.g. employment and self-employment income, government payments

	and interest and other investment income)
	Level of education
	Labour force (e.g. participation rate, employment rate, unemployment rate)
	Cultural indicators (language, traditional knowledge, culture practices, health and wellness, world view, law and order, cultural products, kinship and leisure)
	Infant and maternal health (e.g. birth rate, fertility rate, birth rate of teen mothers, high and low birth weight rate, infant mortality rate, and spontaneous abortion rates)
	Mortality (mortality rate, premature mortality, potential years of life lost)

Table 4.6 Assigning common socio-economic indicators identified from both the EAs and CEAs to health determinants

Health determinants	Health indicators present in at least two projects EAs	Indicators (or baseline data) present in at least two project CEAs
Income and social status	Income level	
	Income sources	
	Infant and maternal health	•
	Mortality	•
	Level of education	
	Labour force	
Social support network	Income level	
	Income sources	
	Labour force	
	Cultural indicators	•
	Infant and maternal health	•
	Mortality	•
Employment and working conditions	Labour force	
	Income level	
	Income sources	
	Level of education	
	Infant and maternal health	•
	Mortality	•
Education	Levels of education	
	Infant and maternal health	•
	Mortality	•
	Income level	
	Income sources	
	Labour force	
Healthy child development	Infant and maternal health	•
	Mortality	•
	Cultural indicators	•
	Income level	
	Income sources	
Biology and genetic endowment	Communicable disease	•
	Infant and maternal health	•
	Mortality	•
	Cultural indicators	•
Health services	Hospitalization	•
	Income level	

	Income sources	
	Infant and maternal health	•
	Mortality	•
Personal health and practices and coping skills	Income level	
	Income sources	
	Labour force	
	Level of education	
	Cultural indicators	•
	Infant and maternal health	•
	Mortality	•

Based on the inventory of VCs and indicators, the number of biophysical VCs and indicators is considerably greater than the socio-economic ones; however, the consistency of common socio-economic VCs and indicators is higher than for biophysical ones. Although there are fewer socio-economic VCs and indicators considered in the three EAs, there is a relatively greater consistency in their use across projects, which may provide valuable baseline information to address the cumulative impacts on the social and community dimensions of health and well-being.

Many of the socio-economic indicators identified from the EAs correspond to the health indicators used for the health determinants. Further, because health determinants are interrelated, most of the socio-economic indicators identified can be used to measure the status of more than one health determinant. Those socio-economic indicators used in at least two projects EAs and CEAs (Table 4.6) thus may be useful to provide baseline information for identifying the health condition changes due to a series of hydroelectric projects, and thereby to predict and monitor the cumulative health effects on communities in the Nelson River watershed. Although it is challenging to determine social health indicators for assessing cumulative health impacts (Mitchell and Parkins, 2011), there may be data already available from project-based EAs that can be effectively used to provide important insight on the impacts of hydroelectric projects on human health and well-being.

4.4 Nature and scope of consideration given to human health and well-being

The following results present the findings based on an analysis of how human health and well-being were approached in the impact assessments of the three project EAs. The analysis was undertaken based on a review of whether the EAs of the three projects adopted a holistic definition of health and a determinants-based framework or approach to health assessment; followed by how health was assessed relative to the biophysical and socio-economic environment.

4.4.1 The adoption of health determinants framework

An explicit definition of health was absent from the EAs of Wuskwatim and Bipole III projects; nevertheless, both of them indicated that human life was affected by various components such as environmental, socio-economic, and cultural conditions. For example, in the EIS of Wuskwatim project, the components that affect human health were identified thusly:

> *many things contribute to the quality of people's lives and experiences and the interplay among these factors affects human and social development…they generally include economic well-being, physical well-being, social well-being and the environment…culture and spirituality are important foundations, in particular for Aboriginal communities (Wuskwatim EIS Vol. 8 Sec. 5, p. 8-225).*

In the EIS of the Bipole III project, the impacts on human health were described as:

> *personal, family and community life is generally looked at in terms of economic well-being, physical well-being (e.g., personal health and safety), social well-being (social supports and services) and the environment (Bipole III EIS Ch. 8, p. 8-314).*

The consideration of human health was slightly more advanced in the Keeyask EA, providing a health definition and claims to adopt a holistic concept of health:

> *Health goes beyond the simple absence of disease. A full understanding of community health also requires consideration of a community's social, physical and economic environments as well as individual factors, which contribute to overall health (Keeyask EIS Ch. 6 p. 159).*

The keyword search term "health determinants" or "determinants" was applied to the EA documents of the three projects to examine whether the concept of health determinants was explicitly addressed, and subsequently used to address human health effects. In Wuskwatim's

EA, the term "determinants" was identified in the socio-economic sections of the EIS, specifically for the topic (or VC) Personal, Family and Community Life. For example:

> *Beyond direct sources, potential changes in the "determinants" of community health (or factors affecting health) as a result of the Project were examined to the extent possible. These include changes in factors that indirectly can affect the health of people, such as housing conditions and income (Wuskwatim EIS Vol. 8 p. 8-290).*
>
> *In the case of the Project, key potential effects on health determinants include: income, employment and training mainly during the construction phase for residents of the Local Region… (Wuskwatim EIS Vol. 8, p. 291).*
>
> *"During the construction phase, indirect effects of the Project have the potential to affect determinants of health (or factors affecting health) for individuals, families and the community as whole" (Wuskwatim EIS Vol. 8, p. 293).*

Although the documents noted that the impacts of the project were related to the health determinants, there was no explicit determinants-based framework or approach adopted to analyze the conditions of the determinants and the impacts of the project on the determinants. The EA recognized that the health determinants included a variety of components, but the explicit use of "health determinants" was only identified for one socio-economic topic. Moreover, there was no information relating to the connection between these determinants with other socio-economic components.

In the EA documents of Bipole III project, the term "health determinants" or "determinants" was not present, and there was no indication that the EA attempted to integrate the framework of health determinants to address the impacts of the project on human health and well-being. In the EA documents of Keeyask project, the term "health determinants" appeared in a supporting technical report to the EIS, Socio-Economic Environment, Resource Use and Heritage Resources, for the topic of Personal, Family and Community Life. In the supporting technical report it was noted that human health was influenced by a variety of health determinants. It also provided a table listing the factors that contribute to health and the link between health and the factors (Keeyask EIS Supporting Vol. p. 5-8). However, the concept of health determinants was ambiguous in the documents because it was used interchangeably with the term "health indicator". For example:

> *The health of individuals, families and communities is shaped by a variety of factors or determinants of health, which included the social and economic environment, the physical environment, and the person's individual characteristics and behaviours (Keeyask EIS Ch 6, P.159).*
>
> *A full understanding of community health requires consideration of both health indicators, (e.g., determinants such as birth rates and infant health, hospitalization and physician visits, communicable disease and mortality)… (Keeyask Socio-Economic Supporting Vol. p. 5-41).*
>
> *The key determinants of health that are expected to be impacted by the Project (either positively or negatively, or both) include indicators of income and social status, employment and working conditions, social environments, physical environments and health services (Keeyask Socio-Economic Supporting Vol. P. 5-174).*

According to the Oxford English Dictionary (2015), 'determinant' is defined as "a factor which decisively affects the nature or outcome of something"; while 'indicator' means "a thing, especially a trend or fact that indicates the state or level of something". In other words, a health determinant is a factor that can determine the condition of human health. An indicator is a measurable parameter that is used to measure, evaluate and present a change in health determinants, and thereby understand how human health is affected. Accordingly, the two terms "health determinant" and "health indicator" are not synonyms, and ought to play different roles in HIA.

4.4.2. Health effect-related indicators

The selection and consistent use of health effects-related indicators is an essential process for HIA. Since human health can be influenced by many factors, the assessment of health effects requires a broad range of health indicators for measurements. The following section presents the results on how health indicators are selected and used in the EAs of the three projects.

The term "health indicator" only exists within the assessment of the socio-economic environment in the EAs examined, and was limited to physical health components. For example, in the EA of Wuskwatim project, health indicators refer to infant and maternal health, communicable diseases, mortality, medical service and hospital utilization (Wuskwatim EIS Vol. 8, p. 257). In the EA of Bipole III project, health indicators include infant mortality, life expectancy and premature mortality rates (Bipole III EIS Ch. 6, p. 210-211). For the Keeyask

EA, health indicators relate to birth rates and infant health, hospitalization and physical visits, communicable diseases and mortality (Keeyask Supporting Vol. Socio-Economic Environment Sec. 5, p. 9-10).

In addition, a number of available baseline data used for other socio-economic VCs that could be used to address health issues were not considered by the project proponents as health indicators for developing an assessment to address holistic health impacts. For example, a number of socio-economic baseline data such as income level, employment and unemployment rate, and education level were provided in the EA documents but none of the project EAs attempted to adopt these data for addressing a holistic analysis of health effects. Some common socio-economic VCs such as community infrastructure and services, aesthetic, culture, and heritage resources were identified as important to human well-being, but they did not have measureable indicators associated with them. Although cultural indicators were provided across all three project EAs, there was no measurement and analysis of health effects conducted based on these indicators.

4.4.3 Human health in the assessment of biophysical environments

Physical environments are one of the important health determinants in Health Canada's framework. As such, in any EA the impact assessment of the project's effects on the biophysical environment is of importance to understanding how the project might affect human health through changes in the conditions of the physical environment. Based on an analysis of the findings from the impact assessment of biophysical environments in the EA documents of the three projects, the linkage between biophysical components (effects on the environment) and human health was limited. Across all three projects, the VCs that were identified as having a potential connection to human health mainly focused on aquatic components. For example, in the EA of Wuskwatim project, the implication of the biophysical effects of the project on human well-being was addressed in the assessment for only one VC – water quality:

> *Water quality affects various human usages of water, including its use for purposes of recreation, irrigation, and drinking water and is also significant from an aesthetics perspective (Wuskwatim EIS Vol. 5 Sec. 5, p. 5-1).*

> *Effects on water quality have been considered in terms of its use as drinking water, for recreation, its significance from an aesthetics perspective… (Wuskwatim EIS Vol. 5 Sec. 5, p. 5-1)*

Besides water quality, there was no evidence that human health was considered in relation to other biophysical VCs, even though several additional biophysical VCs that, when impacted by the project, have the potential to affect human health and well-being, were included in the assessment. These include mercury concentration and internal parasites in fishes and the habitats of caribou and moose – traditional foods for local Aboriginal communities.

In the EA of Bipole III project, human health effects were absent from the impact assessment of biophysical environments. In the EA of the Keeyask project, human health issues were addressed in the assessment of effects to the biophysical environment, but again with specific reference only to aquatic components – water quality and mercury, palatability and cysts in fishes. For example:

> *Water quality objectives and guidelines are more stringent for the protection of aquatic life and wildlife, relative to those established to protect various <u>human</u> usages, including drinking water objectives and guidelines (Keeyask EIS Supporting Vol. Aquatic Environment, p. 2-8)*

> *Due to the detrimental neurotoxicological effects of relatively small amounts of mercury, the frequent consumption of fish with moderate to high mercury concentrations may pose a risk to <u>human health</u>" (Keeyask EIS Supporting Vol. Aquatic Environment, p. 7-2).*

> *Several approaches/information sources were used to describe anticipated effects of the Project on mercury concentrations in fish and their <u>human health-related effects</u>… (Keeyask EIS Supporting Vol. Aquatic Environment, p. 7-8).*

> *Indicators of fish quality for human consumption that are considered in the assessment include: mercury concentration in the expaxial musculature, muscle concentrations of other trace metals, infection rates of lake white with the internal cestode parasite, and fish palatability (Keeyask EIS Supporting Vol. Aquatic Environment, p. 7-1)*

Mercury concentration in selected traditional country foods, especially consumption of fishes, was mentioned in the biophysical assessment, and also specifically discussed in the assessment of socio-economic environments. Mercury concentration in food resources were addressed in the Keeyask EA in relation to both physical health and cultural well-being of the Aboriginal communities. Although the guidelines mentioned above are more stringent, they are not regulations, therefore they are not mandatory.

Impacts identified on other biophysical VCs included in the EA were likely to be of significant importance to the health and well-being of Aboriginal people in the study area; however, health concerns from Aboriginal communities in the study of other biophysical VCs, such as caribou, mosses, and beavers, were not addressed or linked to these VCs or to effects of these VCs. For instance, caribou is one of the most important subsistence and cultural resource for northern Aboriginal people (Wolfe et al., 2000). Aboriginal health and well-being stem from caribou through "the nutritious foods, satisfaction, active lifestyle, and the fulfillment of social and spiritual relationship" (David Suzuki Foundation, 2013). Although the Keeyask project considered the impacts on caribou habitat, the link between caribou and human health social and cultural well-being of Aboriginal people was not identified in the assessment.

4.4.4 Human health in the assessment of socio-economic environments

The assessment of socio-economic environments is designed to address the impacts of projects on human life in local communities. Overall, a holistic concept of human health was adopted and promoted in the impact assessments for the socio-economic environment in the EAs of the three projects; however, human health often existed as a single subset of the assessments and physical health was the primary focus.

In the socio-economic assessment of the Wuskwatim project, for example, the determinants of community health and social well-being were addressed through the assessment of Personal, Family and Community Life. A holistic understanding of community health was suggested:

> *a full understanding of community health also requires consideration of a community's social, physical and economic environment (Wuskwatim EIS Vol. 8 Socio-economic Environment, p. 8-225).*

Community health and social well-being were the two major components related to human health discussed in the area of Personal, Family and Community Life. Community health assessment consisted of two main parts – local perspectives on community health and health status indicators (Wuskwatim EIS Vol. 8 Socio-economic Environment, p. 8-252). Local perspectives on community health included a number of socio-economic factors, such as economic development, health facilities, and health care programming (Wuskwatim EIS Vol. 8 Socio-economic Environment, p. 8-252). For the health status indicators, the focus was on health indicators related to physical health elements, such as infant and maternal health, communicable disease, mortality, and medical service and hospital utilization (Wuskwatim EIS Vol. 8 Socio-economic Environment, p. 8-257). In addition, an overview of social well-being in affected First Nation communities was included in the assessment through concerns of such components as environmental health, home environment, personal and family well-being, community infrastructure and employment opportunities (Wuskwatim EIS Vol. 8 Socio-economic Environment, p. 8-262). Overall, the assessment included a holistic perspective of health; however, detailed analysis of the baseline information was lacking to describe the health conditions of the local communities and predict the impacts of the project on community health. In addition, there were other socio-economic baseline data provided in the EIS, such as the data for economy VCs like participation rate, employment rates, and level of education; however, they were not used for analyzing the impacts of the project on the health determinants for HIA.

In the socio-economic assessment for Bipole III project, it was stated that human life can be affected by a variety of components:

> *personal, family and community life can be affected by the accumulated effects of a variety of Project-related effects (e.g. physical changes to the land, noise and nuisance effects during construction) and will vary for the different Project components (Bipole III EIS Ch. 8).*
>
> *Personal, family and community life is generally looked at in terms of economic well-being, physical well-being (e.g. personal health and safety), social well-being (social supports and services) and the environment (Bipole III EIS Ch. 8, p. 314).*

However, considerations of effects to human health as a VC were limited to physical health issues such as noise, vibration, dust, electric and magnetic fields, and herbicides (Bipole III EIS Ch. 8, p. 314). For other socio-economic VCs, such as economic opportunities, community services, culture and heritage resource, health concerns were rarely addressed in relation with the assessments of those VCs. Again, valuable socio-economic baseline data such as education, labour force and income were provided in a Socio-economic Baseline Report; however, data were not adequately used to address broader social health project impacts and issues.

In the socio-economic assessment for the Keeyask project, effects to human health were addressed in the EIS section Personal, Family and Community life. Community health and mercury and human health were the two major VCs related to human health. A Community Health Assessment was provided to understand the conditions of health and well-being of the local communities. It adopted the holistic concept of health and recognized that:

> *health is influenced by the interaction of a wide variety of factors including physical, mental, emotional and spiritual components (Keeyask EIS Supporting Vol. Socio-economic Environment, p. 5-44).*

The EIS also suggested considering socio-economic factors such as housing, income social status, education, early childhood development, and family and community supports for assessing the condition of community health; however, no measurement of these factors was presented – reportedly due to the challenge of the range of the factors that can contribute to health and the availability of data (Keeyask, EIS Supporting Vol. Socio-economic Environment, p. 5-41). A number of other available indicators such as population, births and infant health, and communicable disease were used for the assessment of community health and to understand the health status of the local community (Keeyask EIS Supporting Vol. Socio-economic Environment, p. 5-44-46). However, although these indicators and available data were provided in the assessment, there was no detailed analysis of these data to evaluate the impacts of the Project on human health. In addition, there was limited consideration of wildlife that are of distinct cultural value to the First Nations, such as boreal woodland caribou. The David Suzuki Foundation (2013), in a report of Cultural and Ecological Value of Boreal Woodland Caribou Habitat, states, "it is important to include the value of the benefits provided by boreal ecosystems when undertaking socio-economic assessments of the protection of caribou habitat."

Mercury and human health was another VC related to health in the socio-economic assessment. This represents an improvement over the previous project EAs, in that the Keeyask EA addresses concerns about mercury concentration in food resources and impacts on physical health, and also recognizes the relation to culture values:

> *The section ends with information on mercury in traditional foods today, focusing on the importance of eating healthy country foods for both health and cultural reasons (Keeyask EIS Supporting Vol. Socio-Economic Environment, p. 5-103).*

A Human Health Risk Assessment (HHRA) was also prepared to assess current and potential increases in mercury concentrations in the environment that may result from the proposed Keeyask Generation Project (Keeyask EIS Supporting Vol. App. 5C). However, the analysis still focused on physical health issues in the HHRA; broader social health issues were not included. Finally, the Keeyask EA's concluding analysis of the residual effects on health only addressed the negative health effects related to the predicted increase in demand for health and social services, and positive effects in the support of employment and equity income (Keeyask EIS Supporting Vol. Socio-economic Environment, p. 242). The impacts due to mercury concentrations and other social health determinants, such as education, social support networks, personal health practices and copping skills, and lifestyle choices were not included in residual effects assessment.

4.4.5 Human health considerations in the EA panel reports

A review of the panel reports, also known as Report of Public Hearings, of the Clean Environment Commission (CEC) indicates that the consideration of human health in project EAs tended to improve gradually from the Wuskwatim to the more recent Keeyask project. The consideration given to human health and well-being in the panel reports increased over time, both in volume and in depth, with the most recent report (for Keeyask) discussing the holistic concept of health, addressing more of the social health determinants, and for the first time addressing explicitly cumulative health effects.

The Wuskwatim project was the first project requiring regulatory EA in the Nelson River watershed, and human health received limited attention in the panel report – aside from consideration of socio-economic and cultural effects (see MCEC, 2004). The concerns related to the well-being of affected communities included employment, training opportunities and culture. For instance, since the key employment period for the project was during construction, which was relatively short-term, the CEC expressed concern that Aboriginal people would be unable to secure the experience and skills needed prior to the construction time frame; thus, the CEC recommended providing monitoring training and employment policies for the Wuskwatim projects (MCEC, 2004). In terms of cultural effects, the CEC reported the concerns from the First Nations who were affected by the project, specifically impacts of fluctuating water levels on the livelihoods, culture, and mental and physical health of the First Nations, such as Pimicikamak Cree Nation (MCEC, 2004). The CEC reported that the indirect cultural impacts of the project were considered to be adverse and were not adequately assessed in the EIS; however, there was no explicit recommendation from the CEC to address these culture effects. The CEC only encouraged the Government of Manitoba to oversee cooperative efforts between Manitoba Hydro and affected First Nations (MCEC, 2004).

In the Report of Public Hearings of Bipole III (MCEC, 2013), the CEC focused on three VCs in relation to health and well-being – public safety, human health, and aesthetics. According to the public hearing report, the major health concerns were those associated with the growth in population due to the influx of workers for the construction of the project. The influx of new workers might result in housing shortages, increased alcohol and drug use, sexually transmitted disease, violence and injury, as well a decrease of social cohesion in the community, thereby leading to an increase of mental health issues (MCEC, 2013). These health issues were not addressed in the EIS. With respect to the effects on aesthetics, the CEC reported that the cumulative changes in the traditional lands of First Nations due to Manitoba Hydro's projects on the Nelson River were said to be directly connected to mental health issues (MCEC, 2013). The CEC recommended that a community health assessment be conducted before the construction of the project, and the baseline information created from the assessment would be available for use for future projects including the Keeyask project (MCEC, 2013).

Finally, in the report of the most recent Keeyask project (MCEC, 2014), there was evidence that the consideration of human health had improved over the previous projects, with more attention given to social health issues as well as explicitly addressing concerns about community health in relation to cumulative effects – something that was not raised on the panel reports of the Wuskwatim and Bipole III projects. The CEC reports that, according to the hearing testimony of an HIA expert, the assessment of human health was enhanced in the Keeyask project by adopting a broad definition of health and health determinants as well as considering many potential pathways through which the project could affect community health; however, the assessment still lacked baseline data on community-based indicators related to alcohol and drug use, injury, food insecurity, sexually transmitted disease and other health issues (MCEC, 2014). Concerning mercury and human health, the CEC focused specifically on monitoring concentrations in traditional foods and its relation to risk to human health in relation to health and traditional foods, noting that traditional foods, including fish, are both culturally important and an important source of nutrients (MCEC, 2014). Thus, the CEC recommended the proponent carry out pre-flood monitoring of fish mercury concentrations in certain locations along the river.

Of most interest to the scope of this research was the attention given to personal, family and community life in the CEC's discussions about cumulative effects. The CEC suggested that there might be a need to provide additional monitoring of community health by the federal and provincial governments to evaluate the potential health impacts resulting from the increase in communicable disease, alcohol and drug abuse, injury and harmful interactions, particularly with vulnerable people, as a result of the increase in development in the region (MCEC, 2014). Mitigation measures, designed to reduce negative interactions between local communities and project workers as well as mitigate the project's impacts on culture and spirituality, were suggested by the CEC to be undertaken prior to future project development in the area (MCEC, 2014).

4.5 Nature and scope of consideration given to cumulative effects on human health and well-being

Since the Keeyask EA is the most recent regulatory assessment of hydroelectric development in the Nelson River watershed; the CEA of the Keeyask project was further examined to understand how cumulative effects to human health and well-being are addressed. The assumption was that being the most recent assessment, it has the benefit of drawing on the previous work and findings of two other assessments in the watershed and should, in principle, represent the more comprehensive CEA of the three projects.

4.5.1 Scoping practices for cumulative effects assessment

One of the criteria used for VC selection in the Keeyask EIS was "overall importance/value to people" (Keeyask EIS Ch. 5, p. 5). Thus, the effects of the project on human well-being ought to be a vital concern for the selection of VCs in any analysis of cumulative effects. Socio-economic VCs are important components for understanding and addressing holistic health impacts; however, some socio-economic VCs identified in the EIS that could have provided important insight into cumulative health effects were excluded from the CEA – namely economy VCs (e.g. employment and training opportunities, business opportunities, income, cost of living, and resource economy) and mercury and human health. The reasons provided for excluding the economic VCs was that the project could generate positive or neutral effects related to these VCs during both the construction and operation phases (Keeyask EIS Ch. 6, p. 438-448). However, the selection of VCs in the CEA failed to consider the potential impacts of the project on human health over a longer period of time.

Although the Keeyask project has the potential to boost the economic growth of local communities during the construction phase due to the increase of opportunities such as for business and employment, accompanying social issues are likely to occur once the construction phase finishes, after which a number of workers may lose their jobs (Health Canada, 2004). Moreover, economic VCs and their associated indicators have the potential to provide significant information to measure and evaluate the conditions generating a change in broader social health determinants over time. The selection of VCs in the CEA failed to consider human health effects in a holistic way. The scoping phase of the project's CEA indeed included a number of socio-economic VCs that related to human health; however, the rationale for VC selection in CEA did not explicitly consider the potential adverse impacts on human health in longer term. The Project's impacts when combined with other past, current and future actions were still limited to the physical environment.

Mercury was identified in the EA as significant to human health for both physical and cultural reasons for local Aboriginal communities. Elevated levels of mercury in fishes resulting from the flooding of reservoirs are a well-documented health issue related to hydroelectric development (World Commission on Dams, 2000; Health Canada, 2004; Namy, 2007). However, the selection of VCs in Keeyask CEA eliminated this important impact due to the reason that

> *residual Project effects on mercury and human health are expected to be adverse during the operation phase only due to the elevated levels of methylmercury in country food…however, there is no spatial overlap with future projects and activities that could also affect methylemrcruy levels (Keeyask EIS Ch. 6, p. 478).*

The reason for screening out the VC mercury and human health from CEA reflects the common error in the practice of CEA in which the potential for adverse cumulative effects are masked or minimized through either faulty logic (e.g. there may be no spatial overlap of projects, but the same VC (fish) is affected) or by comparison with the relative significance of effects caused by other projects (Gunn and Noble, 2012). In the EIS, the proponent described the processes and patterns for the increase of mercury concentration in fishes and clearly stated that:

> *the numerous reports of abnormally high mercury concentrations in fish soon after the impoundment of formerly riverine or lacustrine habitats from geographically distinct and environmentally diverse regions of the world suggest that the above process and patterns of mercury accumulation are a common consequence of reservoir creation (Keeyask EIS Supporting Vol. Aquatic Environment, p. 7-3).*

Therefore, it seems likely that the construction of the reservoir for the Keeyask project would make a cumulative contribution to the mercury concentrations in fishes in the Nelson River that are used by First Nations communities.

4.5.2 Retrospective analysis of cumulative effects

Retrospective analysis is an important process for CEA to determine the trend of change in VC condition and to develop a baseline for measuring cumulative effects, thereby identifying potential thresholds in the VCs for interpreting the significance of cumulative effects (Noble and Gunn, 2013). Identifying the trend of changes in VCs requires the collection and analysis on the same VCs and indicators over time. Based on the inventory on the socio-economic VCs and indicators identified from the EISs and CEAs above, the percentage of VCs and indicators used across all three projects was very low. The limited consistency in the use of VCs and indicators hindered the analysis of trends in the condition of the VCs in the Keeyask project. Data on a number of available health-related indicators were provided in the Keeyask EIS; however, there was no detailed analysis on these data to provide sufficient information related to changes in community health conditions from past to present. Qualitative descriptions of potential cumulative effects were identified, but quantitative data showing trends were not provided.

Thresholds for specified indicators related to human health were limited to physical health conditions. For example, baseline conditions and thresholds related to mercury and human health were provided in the EIS, specifically regarding mercury concentrations in water and country foods (Keeyask EIS Supporting Volume Socio-economic Environment Appendix 5B) and thresholds identified for the mercury concentrations in blood and hair for childbearing women and young children (Keeyask EIS Supporting Volume Socio-economic Environment Ch. 5, p. 57). Effects of mercury on human health, however, were not included in the CEA and, thus, the thresholds not applied to any cumulative effects analysis.

4.5.3 Prospective analysis of cumulative effects

Prospective analysis is typically conducted by using quantitative modeling or scenario-based approaches, though qualitative evaluations are also common, based on retrospective analysis or relevant information gained from elsewhere to predict how the conditions of VCs may respond with additional actions in the same region in the future (Noble and Gunn, 2013). Prospective analysis of human health was absent from the CEA. A vague statement was provided to conclude about the potential impacts on health-related VCs. For example, in Chapter 6 of the EIS, it was noted that any potential impact on health could be caused by a number of health-related components such as increased income, alcohol and drug use, worker interaction, opportunity to access country foods, and worries of local community about the impending changes in their environment (Keeyask EIS Ch. 6, p. 469). In the CEA, however, the cumulative effects of the project on community health were simply described in this way:

> *the additional projects will increase the number of non-local construction workers coming into Gillam, thus increasing the potential for indirect effects on community health. Examples may include the potential for increases in communicable diseases, increased alcohol abuse and adverse interactions with community members such as women and youth (Keeyask EIS Ch. 7, p. 7-49).*
>
> *Operation phase cumulative effects with other future projects may result throughincreased population growth in Gillam associated with these projects, and the potential increase in community health issues. It is anticipated that these adverse indirect cumulative effects will be small to negligible (Keeyask EIS Ch. 7, P. 7-50)*

No detailed prospective analysis was provided in the EIS, or in the CEA, to validate (quantitatively or qualitatively) the findings.

4.5.4 Cumulative effects management measures

The final step in CEA is to identify mitigation strategies followed by an evaluation of significance of residual cumulative effects in order to manage cumulative effects as the effects disclosed. In the Keeyask CEA, significant adverse cumulative effects were anticipated to be "small to negligible" overall. There was no explicit measure for cumulative effects management for either biophysical or socio-economic VCs.

CHAPTER 5

DISCUSSION

This thesis examined the integration of HIA in current project EA, including CEA, by analyzing the regulatory EA documents of three hydroelectric projects in the Nelson River watershed in northern Manitoba. The results of this research indicate that the consideration of human health in project EA has gradually advanced over time; however, there is a lack of adequate analysis of health effects and in particular cumulative health effects. The following sections provide some discussion regarding how to improve the practice of HIA by using available socio-economic baseline data to address broader social health issues; expanding the scope of current health determinants framework and integrating Aboriginal health determinants in future practice to assess the impacts of resource development on Aboriginal people; and addressing cumulative health effects in a more regional and strategic approach.

5.1 Considering broader social determinants of health in EA

First, results indicate that there is a need to adopt a much broader consideration of the social determinants of health in project EA. In the EAs of the three hydroelectric projects examined in this research, although WHO's definition of health was not fully included, the project proponents variably addressed human health in a holistic perspective. However, the overall assessment of health issues and impacts within the project EAs was not satisfactory and was mainly limited to addressing physical health issues. The framework of health determinants developed by Health Canada was designed to assist project proponents to assess inclusive health effects. Nevertheless, the findings indicate that physical environments is the determinant addressed most frequently in the assessments, but the assessment lack analysis of other social health determinants and how physical environments interact with social determinants – an observation that is consistent with observations from previous studies (e.g. Steinemann, 2000; Noble and Bronson, 2005; 2006; Bronson and Noble, 2006; Bhatia and Wernham, 2008; Morgan, 2011). Kwiatkowski and Ooi (2003) suggest that it is not necessary for project proponents to review *all* nine health determinants in detail when developing an EA, but at a minimum all should be considered in brief.

The overall significance of social health determinants and their application in addressing health effects are well recognized, but it remains a challenge for the practice of HIA to blend the social determinants with physical aspects of EAs without overemphasising one element at the expense of others (Kemm, 2004; Bronson and Noble, 2006). Birley (2007) argues that an EA is usually undertaken by environmental specialists and the environmental (i.e. biophysical) components are usually the priorities in the assessment because they are required by legislation. Environmental specialists have jurisdiction in EA but, a relative lack of knowledge and competence in addressing health issues leads them to believe, erroneously, that current practice in EA already takes full consideration of health (Birley, 2007). As a result, in terms of practice, the available data obtained from project EAs are rarely used to develop causal pathways between an environmental triggers and health outcomes, or to assess the potential project impacts on health inequalities (Harris and Haigh, 2015). The link between health determinants and impacts on health for analyzing health effects is complex and multi-factorial; thus, instead of predicting the project's impacts on health outcomes, it is more appropriate to focus on determinants, the underlying driving force of changes on health conditions, and the desired effects of projects on those determinants (Birley, 2002; Bronson and Noble, 2006).

A related issue is that the consideration of health determinants is typically limited to the pre-decision stages of baseline studies and impact analysis, but rarely carried over to the post-decision stage for follow-up and monitoring (Noble and Bronson, 2005; Bronson and Noble, 2006). The assessment of health effects conducted during the pre-decision stage alone will limit the early identification and adequate mitigation on health outcomes due to project impacts (Bronson and Noble, 2006). Assessing the real impacts on human health needs to drive the attention of follow-up and monitoring to the health determinants as the underlying factors that contribute to health impacts, and to the desired effects of projects on those determinants (Bronson and Noble, 2006). The EAs reviewed in this study demonstrated little attention to mitigation plans and monitoring of health effects, particularly social health impacts, and no attention to management and monitoring measures for cumulative effects management -- for either biophysical or socio-economic health determinants.

5.2 Adopting an Aboriginal health determinants framework

Second, there is no one size-fits-all framework of heath determinants (Bronson and Noble, 2006), and project proponents need to be flexible and include in their EAs those health determinants that are sensitive to local understandings of health and health needs, reflecting an awareness of the difference in impacts across different population groups (Bronson and Noble, 2006). However, in order to properly address Aboriginal health effects due to project development in any EA, the physical environment is not the only health determinant needed but also a wide range of determinants that capture issues such as social-economic and cultural stress, racism, social diseases, personal development, self-esteem, mental health, and assistance to families left with one or no parents as a result of employment opportunities outside the community (Kwiatkowski and Ooi, 2003; Bronson and Noble, 2006). Aboriginal peoples often adopt an holistic view, considering human beings are part of the environment and connecting their observations and appreciations of nature with their culture, lifestyle, and beliefs (Kwiatkowski and Ooi, 2003; Kwiatkowski, 2011). Aboriginal people's health and well-being also depend largely on subsistence harvesting activity, which is not simply an additional income or food source but essential to the maintenance of social relations. Thus, any environmental disturbance associated with development that might affect traditional lands and foods has the potential to have significant impacts not only on physical health but also on social and cultural well-being.

The impacts of Manitoba Hydro's hydroelectric projects on the health and well-being of northern Aboriginal communities have been well documented (Waldram, 1988; Loney, 1995; Fortin, 2001; Kulchyski and Neckoway, 2006; Hoffman and Martin, 2012; Know History, 2015). Manitoba Hydro is a Crown Corporation, which is a publicly owned utility responsible to the provincial government but operates as a separate entity (Manitoba Hydro, 2010). As such, in comparison to private developers, it might be expected that Manitoba Hydro also shares government's responsibility to ensure the consideration of Aboriginal peoples' well-being, including their health and the health of their traditional lands, and thus give greater consideration to health issues when Aboriginal communities are affected by their project developments. Although Manitoba Hydro has committed to reduce the negative impacts of development and increase the benefits for the First Nations from the hydroelectric facilities though signing a number of agreements and developing partnership with specific First Nation communities for the development of proposed projects, their approach to mitigating the impacts mainly focuses on providing local employment and training programs and creating business opportunities. Arguably, impacts on Aboriginal communities, particularly the loss of traditional lands due to a result of reservoir construction, and the disruption of cultural practices, cannot be simply compensated by such activities as increasing employment rates and improving material life. In the panel report of Bipole III project, for example, representatives of Fox Lake Cree Nation expressed a desire to restore lost lands and resources in order to maintain the overall health of their people and their environment (MCEC, 2013).

Although resource development can bring much benefit to northern communities, such as increased employment rates, business opportunities and other economic advantages, Aboriginal people continue to voice their concerns regarding the significant impacts on the environment and associated social, economic cultural, spiritual and health matters (Kwiatkowski et al., 2009). As such, although Health Canada's determinants of health framework is valuable to facilitating the integration of health in EA practices, more recent thinking on the social determinants of Aboriginal health, developed by Reading and Wien (2009), may be useful to provide guidance for future practices, particularly the development of Aboriginal health indicators in EA. The lives of Aboriginal people are critically influenced by a wide range of social determinants related to physical, emotional, mental and spiritual aspects of health (Reading and Wien, 2009). The social determinants of Aboriginal health are shaped by three dimensions, namely a holistic perspective of health, socio-political context, and life course from a child to an adult (Reading and Wien, 2009). As such, in addition to considering the Aboriginal holistic perspective on health, which reflects the interrelatedness of physical, spiritual, emotional, and mental health dimensions (Reading and Wien, 2009), an Aboriginal determinants of health approach would also give consideration to the socio-political context – ensuring that the impacts of development are accounted for with consideration given to diminished self-determination, historical loss of traditional land, language and culture, as well as social exclusion stemming from colonization (Reading and Wien, 2009); and to the life-course of an individual (e.g. child, youth, adult), including their place and role in the community (e.g. elder, leader).

According to Reading and Wien (2009), Aboriginal health determinants can thus be classified into three groups or types of determinants: distal (e.g. historic, political, social and economic contexts), intermediate (e.g. community infrastructure, resources, systems and capacities), and proximal (e.g. health behaviours, physical and social environment). Proximal determinants are the factors that have direct impacts on health and well-being, such as biophysical and social environments and health behaviours (Reading and Wien, 2009). Intermediate determinants are those that do not have direct impacts on human health but can indirectly influence health through their impacts on proximal determinants, such as health care and educational systems, which can be considered as the origin of proximal determinants (Reading and Wien, 2009). Distal determinants have the most significant influence on population health and well-being because they represent political, economic and social matters, which construct the other two determinants (Reading and Wien, 2009).

The model of Aboriginal health determinants reflects the complex and dynamic interrelations among social, economic, political, historical, cultural, environmental and other forces that have direct and indirect impacts on Aboriginal health (Reading and Wien, 2009). Comparing these to the determinants of health suggested by Health Canada, the framework of Aboriginal determinants provides a stronger connection among political, social, cultural, environmental and other components and, as such, presents an opportunity for a more holistic approach to health integration in EA practice (Table 5.1).

Table 5.1 Health determinants vs. social determinants of Aboriginal health

Health Canada's Health Determinants	**Social determinants of Aboriginal Health**	
Income and social status	Proximal determinants	Health behaviours
Physical environments		Physical environments
Employment and working conditions		Employment and income
Education		Education
Social support networks		Food insecurity
Healthy child development	Intermediate determinants	Health care systems
Biology and genetic endowment		Education systems
Health services		Community infrastructure, resources and capacities
Personal health practices and coping skills		Environmental stewardship
		Cultural continuity
	Distal determinants of health	Colonialism
		Racism and social exclusion
		Self-determination

5.3 The consideration of health-related indicators

Third, implementing a health determinants approach in EA requires the use of relevant health indicators. Indicators are fundamental elements in EA, used to describe baseline conditions and predict the aggregate effects of development (Canter and Atkinson, 2008), and, as such, appropriately selecting and applying indicators in EA is essential for predicting, assessing, managing and monitoring the potential impacts of development human health and well-being. Based on the observations from this research, however, indicators specifically used to assess health impacts are limited. In the EAs examined, indicators appeared much more frequently in the assessment of biophysical impacts than socio-economic or health ones, and those indicators used to assess biophysical conditions were rarely linked to human health issues. This finding is consistent with Harris and Haigh (2015), who note that environmental health concerns related to the changes in biophysical environment such as air and water quality, noise, and soil contamination are often considered; however, the link between those changes and human health outcomes, particularly social or cultural well-being, is not identified. It is crucially important to identify the relationship between changes in physical environments and health outcomes, as it can provide a better understanding of the impacts of projects on community health and well-being (Kwiatkowski et al., 2009).

When used in EA practice, health-related indicators are typically limited to socio-economic assessment. Even then, when provided, it was observed in this study that they often only address physical health factors such as birth rates, mortality rates, and communicable diseases, excluding broader social health components. This is consistent with the results from early studies reporting that health indicators to address socio-economic impacts related to lifestyle, social influences, and wider economic conditions are rarely addressed in project EAs (e.g. Steinemann, 2000; Birley, 2002; Noble and Bronson, 2006), suggesting that there has been limited improvement in practice (see Ehrlich, 2010; Esteves et al., 2012; Westman, 2013; Harris and Haigh, 2015). The lack of available data is often the reason given by project proponents for not addressing broader social health issues in EA (McCaig, 2005). This was also the case in the projects examined in this study; however, a review of the EA documents indicated that there are available socio-economic baseline data for the three hydroelectric projects that have the potential to serve as important indicators for health assessment and provide important insight to health determinants. The available socio-economic data were not adequately applied to analyze the project impacts on the health determinants.

5.4. Consistency in health indicators use across projects in a single region

Fourth, in addition to the need to define indicators of health that can be used in EA to assess, predict and monitor the effects of individual development projects on human health and well-being (Davis and Sadler, 1997), there is also a need for greater consistency in indicator use in development regions in order to understand cumulative health effects across space and over time (Ball et al., 2012). Consistency in indicators is essential in order to identify the trend of changes in environmental and human health conditions due to the impacts of multiple actions across different time periods. Canter and Ross (2010), for example, emphasize the need for the information recorded in project EISs or supporting documents to be used consistently and updated periodically in order to enhance their usability for future effects assessments.

Results from the inventory developed in this thesis, however, indicate that there are few common indicators considered in the EAs across the three projects in the Nelson watershed. This is problematic in terms of understanding cumulative health impacts or risks due to development. Given that the three projects are located in the same watershed *and* share the same proponent – Manitoba Hydro, greater consistency in baseline data collection and indicator use was expected. Some of the variation may be explained by the use of different consultants conducting the EAs; however, this strengthens the need for more oversight and consistency in indicator selection if the longer term, and wider-spread, impacts of development on health and well-being are to be understood. Sheelanare et al. (2013) agree, noting that some consistency between project EAs on monitoring indicators and knowledge sharing is required if project EAs are to be useful to understanding and managing cumulative effects.

One option to ensure greater consistency in the indicators used across projects to assess human health impacts is to ensure greater consistency in the Terms of Reference (ToR) developed for project EAs located in the same region or watershed. The ToR is an important document that specifies what the proponent is expected to address in the EA (Birley, 2007). Canter and Ross (2010) suggest that ToR should not be vague, and it is advisable or even necessary to have explicit ToR that can provide clear guidance for identifying important VEC and indicators for data collection and monitoring programs, resulting in a better understanding of how development projects affect the environment and the local communities (Ball et al., 2012; Noble et al., 2011). The development of ToR, however, needs certain room for flexibility, in order to capture ongoing changes in our understanding of health or new insights gained over time, either through research or emerging from unexpected health concerns. Nevertheless, there currently is no general agreement on how to develop a good ToR for an integrated environmental, social and health impact assessment (Birley, 2007). Further research and analysis of recent practice examples is needed. Part of the challenge is that there is limited knowledge about how to measure how social health conditions may change in the context of natural resource-based development with multiple projects implemented in the same region and with diverse or overlapping timescales (Mitchell and Parkins, 2011).

5.5 Baseline data and data-sharing to support cumulative effects understanding of health impacts

Fifth, at the most fundamental level, baseline or retrospective analyses are needed to understand social condition change in a region, to collect appropriate information for the VCs and their indicators, and to describe and analyze historical to current and even anticipated conditions (Canter and Ross, 2010); equally important, this information must be shared amongst development proponents to support CEAs of their projects (Sheelanere et al., 2013). Information sharing across multiple projects is essential to the practice of CEA, and to understanding potential cumulative health impacts. A project proponent must have this knowledge and expanded perspective in order to understand the potential cumulative interactions of their project with other projects, and even from different industries, developed in the region (Harriman and Noble, 2008).

This is often not an easy task, and project proponents are not always willing to share their data (Noble et al. 2011). Considering the case of the Cheviot Coal Mine Project in Alberta, for example, proposed by Cardinal River Coals Ltd. in 1996, the proponent was required to address the cumulative effects of its project but pointed out two concerns to the EA review panel: first, many components affecting the VCs within the region did not result from the proposed project;

second, the key information required to conduct an adequate CEA of the project, namely data related to forestry and other mining activities in the region, were not available to the proponent for use. The proponent argued that it simply did not have the information needed to carry out CEA of all the projects and activities in the region that could affect the same VCs affected by the project (Harriman and Noble, 2008). The federal government eventually approved the project.

In the case of the Nelson watershed, however, the challenges to establishing baseline data and data sharing amongst proponents to support CEA are even more alarming. The unique case of the three hydroelectric projects examined in this study is that they are located in the same watershed and all share a common proponent – Manitoba Hydro. However, baseline data and data sharing across the projects were still limited. For example, in the panel report of Bipole III project the CEC expressed concern about health issues related to the influx of worker populations; thus, the proponent was recommended to carry out a community health assessment, and then the baseline information would available for use to understand the cumulative impacts of future projects, namely the Keeyask project (MCEC, 2013). In the panel report of the Keeyask project, however, the CEC was told that there was a lack of baseline data on the indicators of such health issues as alcohol and drug use, food insecurity, and sexually transmitted diseases to complete an adequate assessment of the cumulative effects of the Keeyask development (MCEC, 2014). Notwithstanding being the most recent project, and proposed by the same proponent, there was limited analysis of trends over time for understanding the health conditions of affected communities for the Keeyask CEA. Interestingly, in the CEA of the Keeyask project, Manitoba Hydro as the project proponent blames its limitations on the inadequacies in the Bipole III EIS for the limited information made available about the potential effects of the Bipole III project on certain VCs (Noble and Gunn, 2013). However, both the Keeyask and Bipole III projects belong to Manitoba Hydro, and a number of other Manitoba Hydro projects (including the Wuskwatim project) have been developed prior to Keeyask and Bipole III in the same watershed (Noble and Gunn, 2013). Assigning blame for the absence of baseline information on the inadequacy of previous project EAs is curious when the projects share the same proponent. The projects were, however, approved.

The implications of project proponents not giving due consideration to such cumulative impacts on health and well-being, particularly social health, however, can at times be significant.

For example, in the Upper Thelon Basin in Canada's Northwest Territories, four mineral exploration projects were denied development permits by the Mackenzie Valley Environmental Impact Review Board and rejected by the federal government in 2008 due to the cumulative cultural effects to local Aboriginal communities (Ehrlich, 2010). The Upper Thelon is not only recognized as having a high diversity and richness of wildlife but is also known as "The Place Where God Began", and has an extensive history and pre-history of traditional use (Ehrlich, 2010). In 2007, four mineral exploration projects EAs were prepared to acquire permission from the Review Board for development. The Review Board, an independent co-management body made up of members appointed from Aboriginal, territorial, and federal governments (Ehrlich, 2010), has a mandate to consider impacts on a broader spectrum, including biophysical, socio-economic, and cultural effects as well as direct and indirect impacts on people (Ehrlich, 2010). The proponents of the projects intended to compensate for potential adverse social effects by using approaches such as increasing labour force, employing local monitors and retaining a community liaison (Ehrlich, 2010), and concluded in their EAs that the residual social and cultural effects of each project were negligible or slightly positive. Based on community hearings, along with other evidence, the Review Board disagreed and expressed considerable concern about the impacts on cultural values, concluding that the cumulative cultural effects were so significant that the developments could not be approved (Ehrlich, 2010) and issued rejections for all four development proposals.

5.6 Re-examine the scope of legislation and regulatory provisions for health inclusion in EA

Sixth, that biophysical VCs and indicators were given significantly greater attention than health in the three projects examined was not surprising, since the EA system in general tends to give more weight to biophysical impacts in EA practice than to socio-economic ones (Birley, 2007; Bhatia and Wernham, 2008; Esteves et al, 2012; Harris and Haigh, 2015). The limited consideration of human health in project EAs may simply be a reflection of the current legislative context, which has historically favoured biophysical issues in most jurisdictions (Esteves et al., 2012). In the scope of Manitoba's *The Environmental Act*, for example, the focus is first on the biophysical effects and second on how these effects influence other non-biophysical conditions. It can be presented by the definitions of terms that are used in the *Act*.

For example, the term “environment” is defined in the *Act* as “air, land, and water, or plant and animal life, including humans” (The Environmental Act, 1 (2)).

Chadwick (2002), based on a survey of UK legislation and regulation, similarly notes that most of the environmental receptors listed in regulations are biophysical components; human beings as one of the receptors are often implied in the broad definition of “environment”, including human dimensions. This broad definition of “environment” often results in the assessment of socio-economic and health effects treated elsewhere in the project authorization process, rather than as part of the EA itself (Chadwick, 2002). Moreover, the *Act* and regulations do not specify which effects need to be assessed; instead, the *Licensing Procedures Regulation* has a requirement that a proposal for any class of development must include “type, quantity and concentration of pollutants to be released into the air, water or on land; impact on wildlife; impact on fisheries; impact on surface water and groundwater; forestry related impacts; impact on heritage resources; socio-economic implications resulting from the environmental impacts” (Section 1(1) (j) (i-vii)). However, the impacts on human beings are not distinctly included in the regulation. Results from the Manitoba context are consistent with those reported elsewhere in the literature, is that the assessment of human health, particular the social dimension is often neglected, secondary, or not required by EA legislation (Birley, 2007).

5.7 Approaching human health effects in a regional and strategic CEA

Finally, many studies in the field of impact assessment have criticized the current practice of CEA under project-based EA legislation for emphasising project approval rather than sustainability (Duinker and Greig, 2006; Harriman and Noble, 2008; Noble, 2010); for lacking in the consideration of cumulative social and economic impacts (Canter and Ross, 2010; Mitchell and Parkins, 2011; Westman, 2013); for facilitating only limited multi-stakeholder collaboration (Dube, 2003; Canter and Ross, 2010); and for giving limited consideration to cumulative effects in decision making (Noble, 2010; Seitz et al., 2011). Some scholars have suggested that the practice of CEA may be beyond the capacities of a single project proponent and requires the participation and collaboration of regulators, stakeholders, and developers to establish environmental and socio-economic objectives as well as to manage development on a regional basis, guided by broader regional planning and sustainability goals (Noble, 2010). As such, there is increasing attention being paid to applying a regional and strategic approach to the practice of CEA at broader spatial and temporal scales, often beyond the project-based EA process, in order to develop a more flexible and powerful mechanism to better understand, evaluate and monitor the sources of cumulative environmental change (Dube, 2003; Harriman and Noble, 2008; Noble, 2010; Franks et al., 2010). In the panel reports of Wuskwatim, Bipole III, and Keeyask projects, the CEC consistently recommended the need for developing a Regional Cumulative Effects Assessment on the Nelson River systems to address past, current and future hydroelectric development. From the panel report of Bipole III project, the non-licensing Recommendation 13.2 by the CEC states:

> *Manitoba Hydro, in cooperation with the Manitoba Government, conduct a Regional Cumulative Effects Assessment for all Manitoba Hydro projects and associated infrastructure in the Nelson River sub-watershed; and that this be undertaken prior to the licensing of any additional projects in the Nelson River sub-watershed after the Bipole III Project (MCEC, 2013).*

Accordingly, Manitoba Government and Manitoba Hydro recently jointly undertook a Regional Cumulative Effects Assessment of hydroelectric development associated with LWR, CRD and other related transmission projects in a way to address CEC's recommendation (Manitoba Hydro, 2014).

Human health impacts must invariably be addressed in EA; however, adequately monitoring and evaluating cumulative health impacts may require a more regional and strategic approach – an approach designed to provide greater opportunity for the collaboration of government agencies and industries with regional stakeholders to establish shared visions and responsibilities to support assessment, implementation, and monitoring and follow-up programs (Noble, 2008). Arguably, integrating human health effects within such a broader regional and strategic CEA context presents an opportunity to significantly improve health assessment practice and understanding. This does not mean, however, that project proponents do not share a responsibility for assessing and mitigating the health impacts of their projects. Further, facilitating broader regional and strategic approaches to CEA for health requires even greater attention to health in project EA – ensuring that determinants are assessed, that attention is given to social and biophysical health issues, that common indicators are used across projects in the same region, and that legislation be enacted to require that baseline data are maintained and shared amongst developers. The benefits to project proponents include a reliable and consistent database for assessing their own project's impacts and meeting regulatory requirements, and doing so with greater efficiency (Gibson, 2012).

Complicating the issue, however, is that in Canada such regional and strategic assessments are non-statutory and largely conducted on an *ad hoc* basis – and when implemented have often had limited influence over project development and decision making (Noble, 2009). Including human health and well-being in regional and strategic EA, nested within broader approvals system of environmental legislation, is fertile ground for future research (Harris et al., 2015). Further, linking human health to such policy and practice framework is a potential tool for further conceptualising and unpacking the conditions that contribute to the better integration of health and well-being in project EA (Harris and Haigh, 2015).

CHAPTER 6

CONCLUSIONS

The development of hydroelectric projects has significant impacts on both the natural environment and human health and well-being. In Canada, the construction and operation of a hydroelectric project is usually subject to regulatory review under either federal or provincial EA legislation, or both, to identify, predict, manage and monitor the impacts on the environment, including biophysical, socio-economic, health and well-being and cultural components. Health impact assessment is typically an integrated component in the regulatory framework of EA to assess and manage the impacts of resource development projects on human health and well-being. In Canada, the approach to HIA adopts the WHO's holistic definition of health – "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity" (Health Canada, 2004) – to address health issues in a holistic dimension. However, many studies indicate that the assessment of health impacts in project EA is often limited to physical health issues without due consideration on broader social health determinants, and done on an *ad hoc* basis (Davis and Sadler, 1997; Steinemann, 2000; Noble and Bronson, 2005). Further, within the framework of EA, the assessment of cumulative effects also focuses mainly on physical environments, with arguably less attention to human health and well-being. As such, this thesis was developed to examine the current state of how human health effects, including cumulative health effects, are considered within regulatory EA practice, and perhaps how this could be improved. This was done by examining the EAs for three hydroelectric projects located in the Nelson River watershed in northern Manitoba.

The findings from the review of the EAs of the three projects indicate that biophysical environments are given significantly greater attention and consideration in EA than other social and health issues. The consideration of human health and well-being has gradually improved in the assessments over time; however, the assessment of health impacts was invariably limited to physical health issues. There was a lack of consideration of the impacts on other social health determinants. Physical environments, as a determinant, were addressed most frequently in the assessment; however, the assessments of health impacts associated with physical environments were mostly limited to the aquatic environment concerning water quality and mercury concentration in fish.

Indicators are important components in EA to measure and describe the baseline condition changes of selected VCs, and thereby to predict and manage the impacts of development on both biophysical and socio-economic environments. In the EA documents examined, the term “indicator” appeared more frequently in the assessment of biophysical environments than socio-economic environments. In the socio-economic assessment, the indicators particularly used to address health issues largely referred to physical health factors such as birth rates, mortality rates and communicable diseases. The inventory developed in this study identified a set of socio-economic indicators, and associated baseline data provided in the documents, which could be used as health-related indicators to address the impacts on broader social health determinants. Nevertheless, those baseline data were not applied effectively to measure and assess the potential social health impacts. In addition, the HIA of the three projects was still limited to the pre-decision stage of EA for describing the baseline conditions of health with little attention to mitigation plans and monitoring programs.

Maintaining consistency in indicators is essential to identify changes in environmental and human health conditions over time and across projects, and is particularly important to understanding the cumulative changes in conditions due to the impacts of multiple projects. In the inventory of the VCs and indicators developed in this thesis, the consistency of VCs and indicators used across the three projects was very limited. Comparing the biophysical environment VCs and indicators to the socio-economic ones, however, the use of socio-economic VCs and indicators tend to have relatively better consistency than the biophysical ones. Accordingly, the assessment of cumulative effects on socio-economic environments may have better quality information obtained from the VCs and indicators used over time and across projects. The EA of the three projects should have the capability to maintain adequate consistency in their VCs and indicators, because the three projects are located in the same watershed *and* share the same proponent – Manitoba Hydro.

In the in-depth analysis undertaken regarding the practice of CEA for the Keeyask project demonstrated that there was lack of consideration of human health issues in each of the basic components of CEA – scoping, retrospective analysis, prospective analysis, and management measures. In the scoping process, the selection of VCs in the CEA did not adequately consider the impacts of the project on the health-related VCs over a longer time and often masked the cumulative impacts based on assessing those impacts relative to, versus in addition to, adverse change that has already happened. In addition, a retrospective analysis requires baseline information obtained from trends in VCs conditions based on measuring the same indicators consistently; however, due to the poor consistency of use of the health-related VCs and indicators, there was not sufficient baseline data to conduct the retrospective analysis to support CEA. Without such baseline information, prospective analysis for predicting how the VCs conditions may respond to the impacts from additional projects in the future could not be successfully implemented. There were no explicit follow-up monitoring and mitigation program found in the CEA to manage the cumulative effects on either biophysical or socio-economic VCs.

6.1 Implications for research directions and improvements in practice

Regulatory EA required in the development of natural resource projects is intended to support sustainable development. Human beings are considered as the centre of concern for sustainable development (Health Canada, 2004); however, the biophysical environment is invariably the focus in EA and such changes in the biophysical environment, when associated to human health and well-being, are typically associated only with physical health as opposed to broader social health conditions. Although the current practice of EA considers impacts on human health issues, they are limited to physical health components. There is a need to expand the scope of HIA in current practices to comprehensively include the impacts on broader social health determinants, particularly Aboriginal determinants because the natural resource developments in Canada are often located in areas inhabited mainly by Aboriginal peoples and their health highly depends on access to land and resources. The framework of Aboriginal health determinants developed by Reading and Wien (2009) may be adopted in future practices for providing guidance to address Aboriginal health issues and inequalities with the connections at proximal, intermediate and distal levels.

Although there were health-related baseline data included in the EA documents analyzed in this study, they were not effectively used to address health issues and, in particular, cumulative health effects. Thus, there is a need to develop explicit ToR for project proponents, which can provide guidance for identifying appropriate environmental and health indicators and maintain consistency in the indicators used across projects and over time for environmental and health impact assessments. In addition, the practice of CEA in Canada often is based on guidance contained in the Cumulative Effects Assessment Practitioners Guide (Hegmann et al., 1999); however, the Practitioners Guide mainly focuses on cumulative biophysical effects. Thus, there is lack of current guidance for addressing cumulative social and health issues. A draft of new Technical Guidance for Assessment Cumulative Environmental Effects under the *Canadian Environmental Assessment Act, 2012* was recently developed by Canadian Environmental Assessment Agency (CEAA, 2014). In the draft of the Technical Guidance, the Agency explicitly states that "the value of a component not only relates to its role in the ecosystem, but also to the value people place on it" for the identification of VCs considered in the CEA. This is only a minor improvement over the previous guidance, and further direction is needed for project proponents on how to assess cumulative health effects in project EA.

Finally, the assessment of cumulative effects is best undertaken at broader spatial and temporal scales, which is often beyond the capacity of project proponents under project-based EA. The assessment of cumulative effects on health and well-being needs to be approached in a more regional and strategic framework of CEA in future practices, which includes such benefits as making sure holistic health determinants are considered; developing reliable and consistent baseline data for addressing impacts on health and well-being; and developing better collaborations among project proponents, government agencies and other regional stakeholders. Current research on SEA, however, has only recently begun to address the potential integration of HIA (Wright et al., 2005; Fischer et al., 2010; Linzalone, 2014) and further research is needed to develop methodology and understand how to effectively incorporate HIA into policy and institutional framework evaluations.

6.2 Limitations

There were a number of recognized limitations to this research. First, the review of health integration in EA and CEA was based on the EA documents of only three hydroelectric projects. The sample size was small. However, significance of the limited consideration of cumulative health effects and the lack of consistency in the consideration of human health-related issues in the assessments of three projects in the same watershed, all conducted by the same project proponent, would be difficult to refute. Second, most of the EA documents were available in electronic form, except the EIS and associated documents for the Wuskwatim project – these were available only in original hard copies. The review of the documents was somewhat more challenging than reviewing those in electronic form, such as in finding key words; thus, the quality of the data extracted from the Wuskwatim project may be affected by the manual search procedure – such project assessments contain hundreds to thousands of pages of text and data. Third, a standard methodology for evaluating the quality of CEA practices regarding health impacts is lacking. The methods used for the evaluation were adopted from other types of impact assessments, which do not specifically consider health impacts. Finally, the organization of environmental and human health components for the inventory was done as an inductive process by a sole researcher who was lacked expertise in both biophysical assessment and public health fields. Accordingly, a number of assumptions were made for the organization and identification of the VCs and indicators, especially for the identification of human health indicators. Although Health Canada's determinants framework, supported by the scholarly literature, informed the identification and classification of indicators, it is possible that others undertaking the review may assign some indicators to different determinants. Though, based on those indicators that appear to be used most often in practice and identified in scholarly research, it is unlikely that significant differences in classification would exist.

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